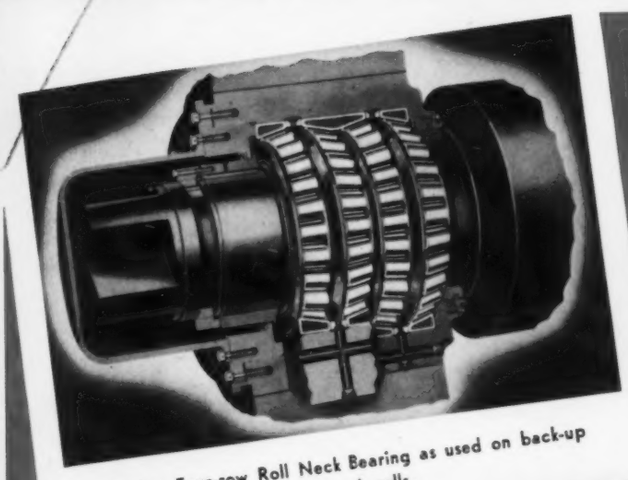
Iron and Steel ENGINEER

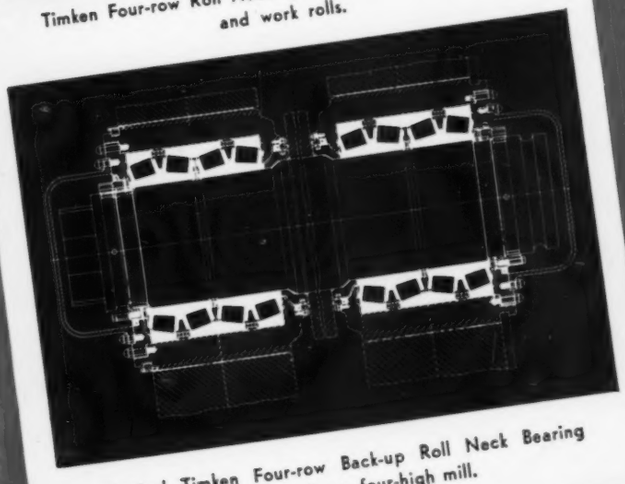
ENGINEERING SERVICE
TO THE IRON AND STEEL
INDUSTRY SINCE 1907

1010 EMPIRE BUILDING | March, 1943 | PITTSBURGH, PA.

MAR 2 7 1943
DETROIT



Timken Four-row Roll Neck Bearing as used on back-up and work rolls.



Typical Timken Four-row Back-up Roll Neck Bearing mounting for a four-high mill.

The One Test For Every Decision—
Will It Help To Win The War?

"... There Is TIMKEN In Bearings"
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

Keep your Steel Mills rolling for Victory with all rolls on Timken Bearings.

Operators of rolling mills equipped with Timken Roll Neck Bearings find the *simplicity* of these bearings a big advantage —especially under war-time conditions.

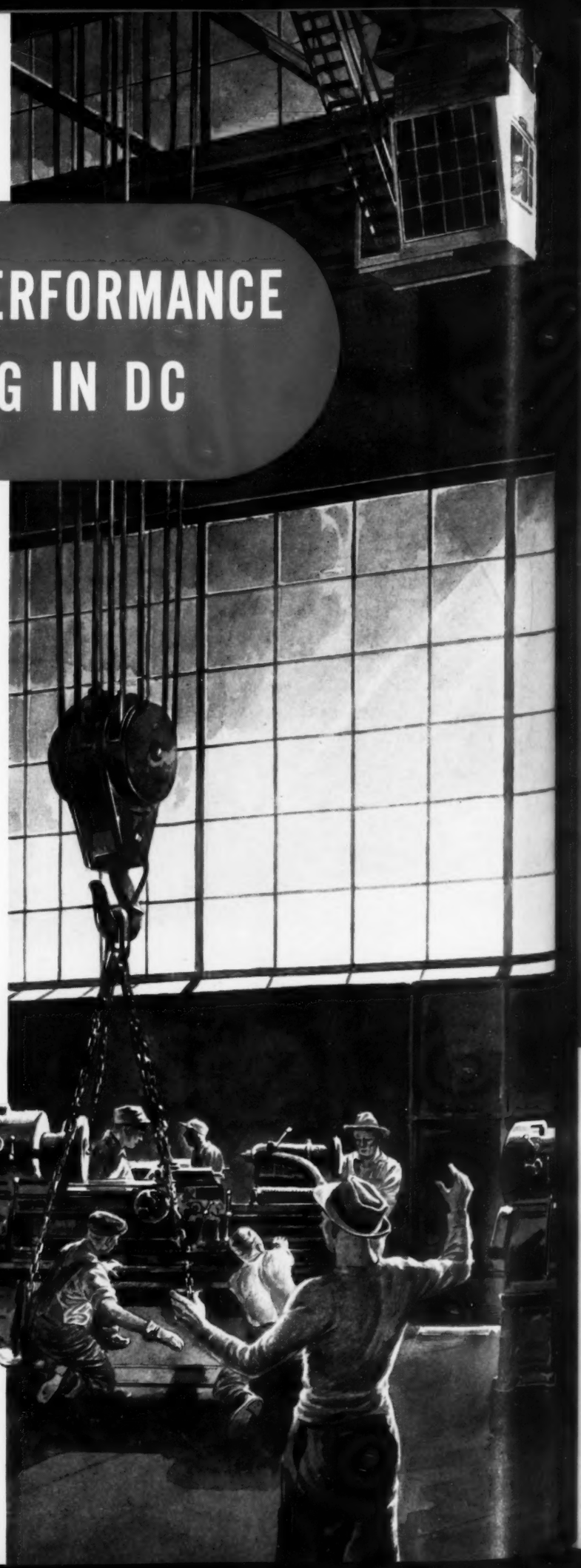
For instance, Timken Roll Neck Bearings do not require complicated lubricating systems, so there are no delicate parts to handle when changing rolls; this makes roll changing quicker and easier.

Another thing, there is no adhesion of bearing surfaces during involuntary shut-downs, so mills can be re-started without releasing roll pressure. This saves steel because the gauge is maintained constantly under all conditions.

Furthermore, the tonnage records of Timken Roll Neck Bearings are unsurpassed by any other roll neck bearings. It will pay you to keep these points in mind when buying new mills or modernizing existing ones. The Timken Roller Bearing Company, Canton, Ohio.

now!

PERFECT CRANE PERFORMANCE WITHOUT PUTTING IN DC

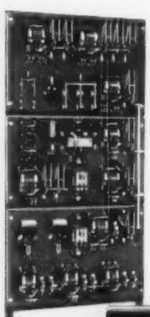


New C-H Control provides dynamic braking, full range of stable lowering speeds, accurate inching . . . all on AC

Cutler-Hammer engineers have answered another long-standing problem of industrial America. Factories can *now* operate cranes on alternating current. No need for installing expensive generating equipment when direct current is not available. No costly, troublesome load brake for a makeshift lowering arrangement.

The new Cutler-Hammer AC Crane Control for the first time provides dynamic braking over a full range of 5 stable lowering speeds on alternating current operation. It provides accurate inching for spotting loads, setting slings, etc. Its response never varies . . . operators can trust it and save time.

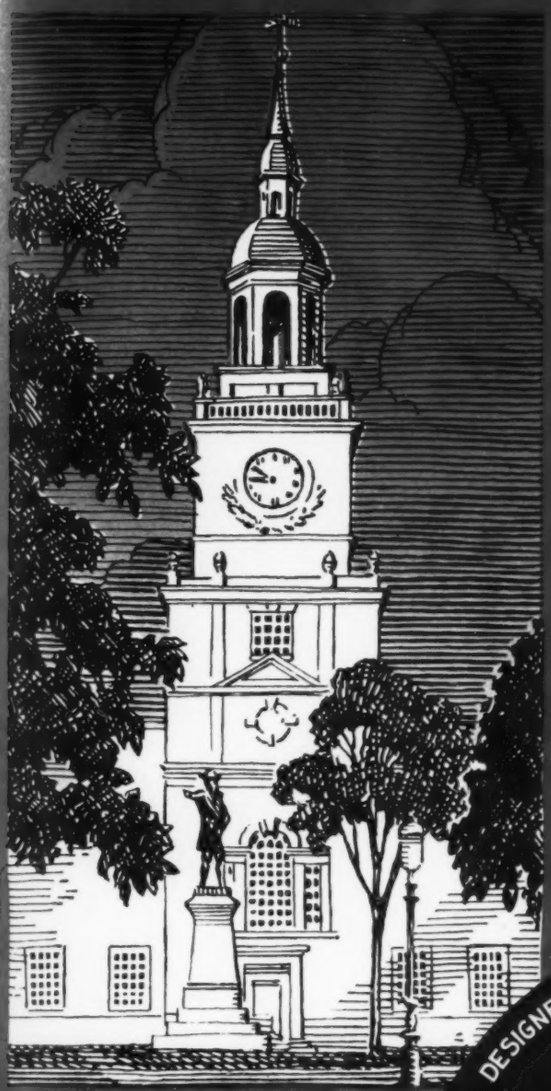
You should insist on this outstanding engineering advance for your next crane. Write or wire *today* for full information. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.



An ingenious control system solved the problem. Standard AC motor and this panel of standard Cutler-Hammer units do the entire job.

CUTLER·HAMMER
MOTOR CONTROL
C-H

SYMBOLS of FREEDOM



"We Hold These Truths To Be Self-Evident"

Independence Hall . . . here in 1776 the Declaration of Independence was signed . . . a document that was destined to pattern the American Standard of Liberty. Since that eventful day we have been through many a crisis and in each instance we have emerged a stronger nation than before. Now we are faced with our greatest test, firm in the belief that courageous action and self-sacrifice will enable America to attain her rightful position as a leader of nations.

DESIGNERS AND BUILDERS TO THE STEEL, NON-FERROUS AND CHEMICAL INDUSTRIES

The AETNA-STANDARD ENGINEERING COMPANY

★ YOUNGSTOWN, OHIO, U.S.A. ★

ARMY E NAVY

ASSOCIATED COMPANIES

HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND •
JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA

AETNA TWELVE ROLL TUBE STRAIGHTENER

Steel mill engineers want ruggedly built, quality cranes for every department. They know that little else can so hold up production as a weak-sister crane.

For this reason a great number of all-welded Cleveland Cranes is serving the steel industry. Regardless of capacity or span they are heavily constructed to stand the gaff.

THE CLEVELAND CRANE & ENGINEERING CO.

1131 EAST 283 RD ST. WICKLIFFE, OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops and Shorts

BIT by bit, plate production keeps moving upward. January established a new record of 1,135,413 tons, of which 565,893 tons came from the continuous strip mills. Plate production could be higher, but has been held down in recent months by government scheduling.

▲

USING pure metal powders, moulded to exact size and shape in one operation, powder metallurgy is contributing to the war effort in the production of many small parts of special design and shape with considerable economy of fabrication. While conserving materials and man-hours, the process permits the use of alloys not attainable by other methods. Tolerances not possible by ordinary methods are readily maintained, and other special characteristics may be imparted.

▲

YOU might not think that 1942 record of 235 billion cigarets, 159 million gallons of liquor, 65,000,000 barrels of malt liquors and 47,000,000 packs of playing cards represented a war economy until you also realize that we also put out 48,000 military airplanes, 56,000 combat vehicles, 17,000 anti-aircraft guns, 21,000 anti-tank guns, 670,000 machine guns and 8,200,000 deadweight tons of merchant ships in the year since it became fashionable to rhyme tap, slap and Jap.

▲

WITH aluminum production approaching the million-tons-a-year mark, magnesium at one-third of a million tons, and plastics growing by leaps and bounds, we can't help thinking of the new competition to be faced by the steel industry when we again reach a peace-time footing.

▲

ABSENTEEISM is said to be running as high as 10 per cent in some industrial sections of the country. With 2 per cent considered a reasonable figure, it makes you wonder whose side the other 8 per cent are on.

▲

REMEMBER when a married man with an annual income of $5000 paid $7.88 income tax?

BEATING through former ocean beds now forming the states of Idaho and Wyoming, government geologists have discovered a deposit of vanadium ore which should go far toward making the nation self-sufficient in this vital metal. Development tunnels are being driven and vanadium from this source is expected to flow soon to feed industry's demand.

▲

ORE vessels must make 39 or 40 trips next season instead of the 37 made in 1942 if the 101,000,000 tons of lake ores projected for water-hauling is to be reached. Predictions for 1943 steel production now stand at 93,000,000 tons.

▲

NOT new, but again recurrent, is the idea of applying an electric arc to ingot hot tops as a possible means of increasing output and reducing cost, particularly on special alloy steels. Used in the United States on roll castings and nickel ingots, the process results in decreased piping and less carbon and sulphur segregation. Data from abroad show consumptions of 3-4 lb of graphite electrodes and 20-40 kwhr per ton, with all metal below the hot top sound.

▲

DESPITE the distraction and ravages of their all-out military effort, the Russians report completion of the first section of a new iron and steel works at Chelyabinsk, east of the Ural mountains. When completed, this plant will be the Soviet's largest producing unit for high quality steels.

▲

SOME interesting items were reported at the recent meeting of the Eastern States Blast Furnace and Coke Association in Pittsburgh. One operator stated that pig iron production in his plant was increased 10-12 per cent merely by sizing the materials charged. Another plant reported a production rate of 3.3 tons per day per sq ft of hearth area on a small furnace which was blown at a rate of 200 cfm of blast per sq ft of hearth area. It was stated that investigations indicated the critical figure to be cfm of blast per sq ft of stockline area, and that a value for this not exceeding 240 gave satisfactory furnace operation, regardless of the resultant figure thus given on the hearth area basis. This merits further investigation, and, if conclusively proven, should lead to a higher ratio of stockline to hearth in the future.

▲

NO one even remembers how we worried when the national debt limit had to be raised above $45,000,000,000.

▲

OF the two certainties, death and taxes, it is hard to decide which is the more troublesome these days.

▲

WITH the exception of rubber, Washington now seems to be less concerned over raw materials, many of the former critical spots having been bolstered up.

TIME IS SHORT!

~~FUEL OIL~~
~~NATURAL GAS~~

Change to the Victory Fuel now!

AMCO
PULVERIZED COAL
Systems

with
automatic control
for HEATING MELTING AND ANNEALING

Fuel oil and gas *must* be replaced *now* with pulverized coal, if operations are to continue at their present record rate. • AMCO is prepared to furnish complete Pulverized Fuel Systems for all types of furnaces in the Steel and Non-Ferrous Industries.

2

The AMSLER-MORTON *Company*
FULTON BUILDING · PITTSBURGH, PA.

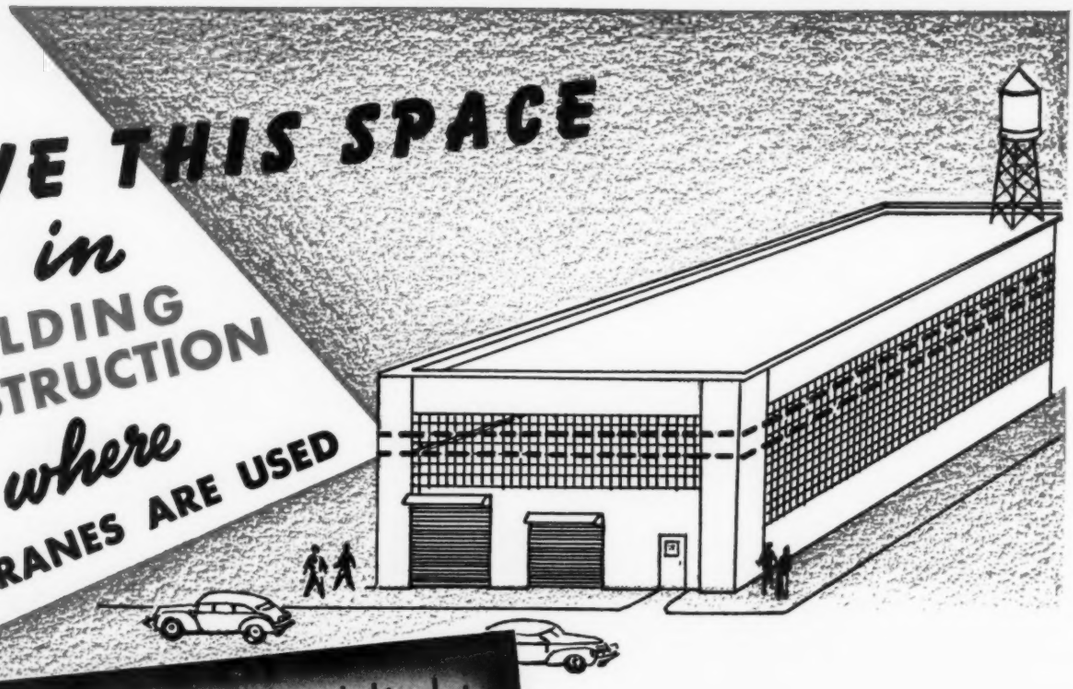
BETTER FINISH - INCREASED TONNAGE

LEWIS ROLLS AND ROLLING
MILL MACHINERY COMBINE
TO HELP **SPEED UP PRODUCTION.**

LEWIS ROLLS

LEWIS FOUNDRY & MACHINE DIVISION OF BLAW-KNOX CO., PITTSBURGH, PA.

SAVE THIS SPACE *in* BUILDING CONSTRUCTION *where* D-C CRANES ARE USED



Reduce heating and lighting needs—less piping too

THE cost of the horizontal section of building, illustrated above, represents a big investment. To include it means deeper footings, heavier building columns, extra requirements for heating, lighting, ventilating, etc.

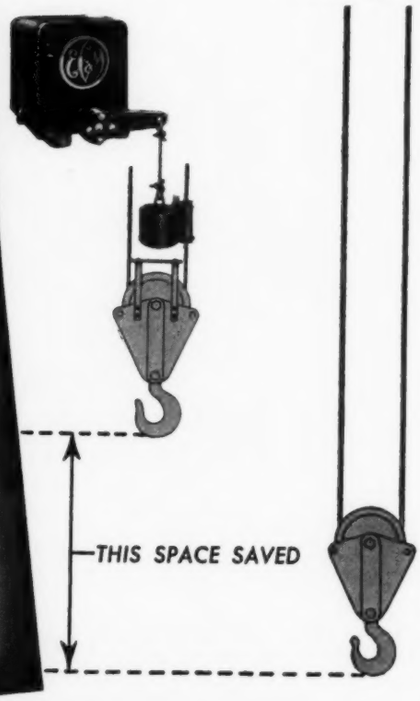
When such a building has D-c cranes geared for high production and equipped with anti-friction bearings, the hoisting speed of the empty hook may be as much as 2½ to 3 times full motor speed. This means that the tripping point for a circuit-opening limit stop must be set with sufficient clearance to insure safe stopping under this worst condition (empty hook at high speed).

The EC&M Youngstown Safety Limit Stop can materially reduce this distance and save construction costs. This Limit Stop not only disconnects the motor from the line but aids the hoist-brake in bringing the hook to rest quickly by dynamic braking. And being operated directly by the hook-block, stretching of the hoisting cables in no way affects the *final* stopping point.

Before planning new buildings, investigate this EC&M Youngstown Safety Limit Stop. Bulletin 1035 gives complete description and shows many interesting illustrations of how it is applied to overhead traveling cranes. Write for a copy.

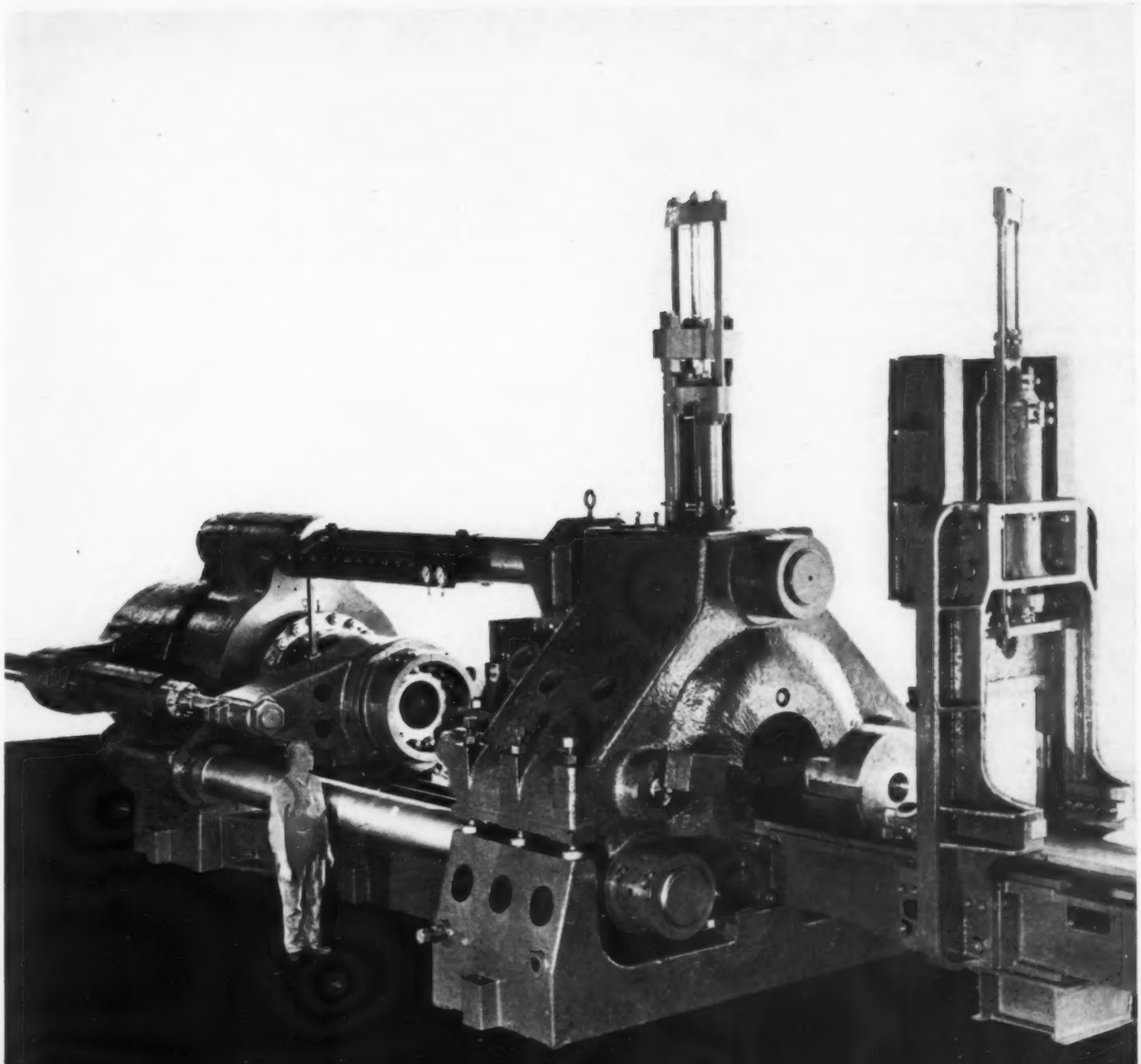
QUICK-STOPPING type of LIMIT STOP gives MINIMUM DRIFT

CIRCUIT-OPENING type of LIMIT STOP requires GREATER CLEARANCE for DRIFT



THE ELECTRIC CONTROLLER & MFG. CO.

CLEVELAND ★ OHIO



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570 LEXINGTON AVENUE · NEW YORK · N. Y.

MORE STEEL AND

LESS COST WITH SALEM

AN INGOT HEATING FURNACE, NOT JUST ANOTHER SOAKING PIT

Salem Soaking Pits, unlike all others, are in principle and practice INGOT HEATING FURNACES, and have a circular shape. Operating men generally accept the fact that the most important requirement for proper rolling of steel is TEMPERATURE UNIFORMITY. It has been proven by actual tests that Salem circular pits maintain A MORE UNIFORM TEMPERATURE FROM TOP TO BOTTOM than do the pits of other designs. It is not surprising, therefore, that years of production data on Salem Circular Ingot Furnaces reveal new production achievements that include increased tonnage, better quality, and lower costs.

IT WILL DO MORE

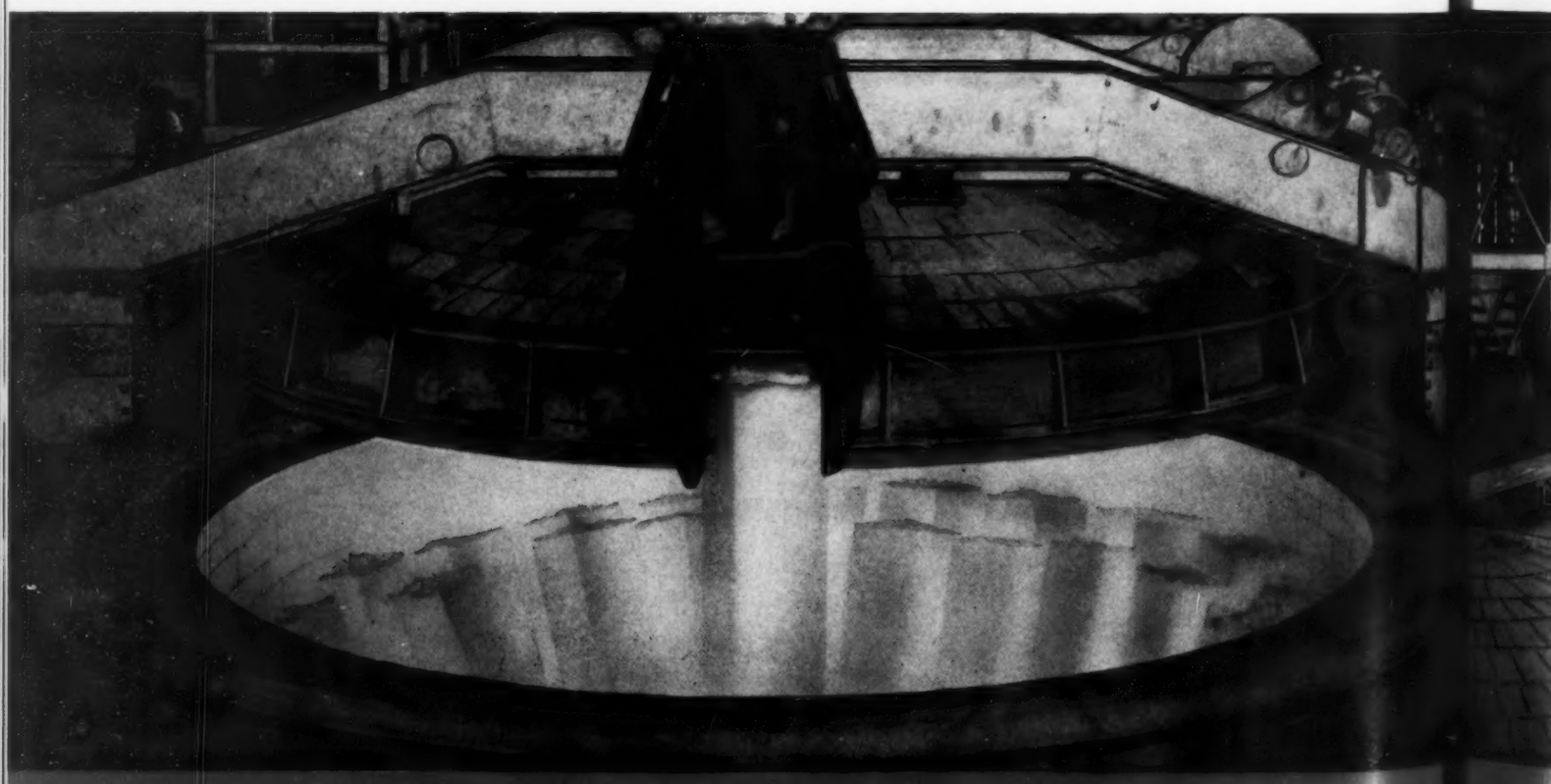
Twenty-five percent faster cycle than with other types of soaking pits—that's the result of heating cold or hot carbon steel, or alloy ingots in Salem Circular Soaking Pits. There's no better method, especially for alloy steel since the empty pit may be quickly cooled to the proper temperature for charging. Having accurately controlled temperature—as accurate as any heat treating furnace—Salem equipment heats ingots uniformly from top to bottom. Better yet, all the ingots in a charge and in each subsequent load have the same temperature. This permits faster, safer rolling, plus steel with better surface. And best of all, since Salem Pits are circular, thus having NO FORGOTTEN CORNERS, they will heat more ingots more uniformly per square foot of occupied floor space than square or rectangular pits.

FOR EXAMPLE: The heating rate for a 16 foot Salem Furnace is about 15 tons per hour with cold steel, and as high as 38 tons per hour with hot steel. One case shows where nine cold ingots, each weighing 26,000 pounds, a TOTAL OF 234,000 POUNDS IN ONE 16 FOOT HOLE, are uniformly heated from cold to rolling temperature of 2450° F. in 7 hours, 15 minutes. Furthermore, the scale is unbroken and the ingots are in excellent condition for rolling. THAT IS NOT ALL—in comparison with the results of using the regenerative practice, it is found that edge cracking from overheating is about 40% less with Salem Pits. Hence, the savings in chipping costs are enough to pay for the entire fuel consumption of Salem Ingot Heating Furnaces.

SAVINGS—Salem's accurate control of ingot temperatures eliminates all guesswork, thus permitting a minimum thickness, single jacket scale formation. Thus, Salem Ingot Heating Furnaces reduce the scale formation by at least 1%. In addition to this scale saving by superior heating, the yield also increases as much as 1%. Therefore, Salem Circular Furnaces provide savings through faster production in less space, more uniform quality, better rolling, better finish, higher yield, and lower costs.

INGENIOUS DESIGNING

Since Salem Pits are circular in shape, there are NO



SALEM ENGINEERING C

BETTER STEEL AT
CIRCULAR SOAKING PITS

COLD POCKETS and NO FORGOTTEN CORNERS. A multiplicity of burners is placed outside the furnace near the bottom for accessibility, and heat from them enters the combustion rim at a tangent to the circular furnace wall. This method avoids direct impingement on either the ingot or the furnace lining. The active heating gases move in a spiral path as a result of the circular shape of the pits as well as the tangent method of directing the heat into the chamber. Hence, the hot gases are in contact with the ingots longer than in any other type of pit and with relatively low burner velocities. Furthermore, brickwork maintenance is kept to a minimum due to this method of firing and circulation whereby there's no direct impingement. This firing method also provides for better combustion.

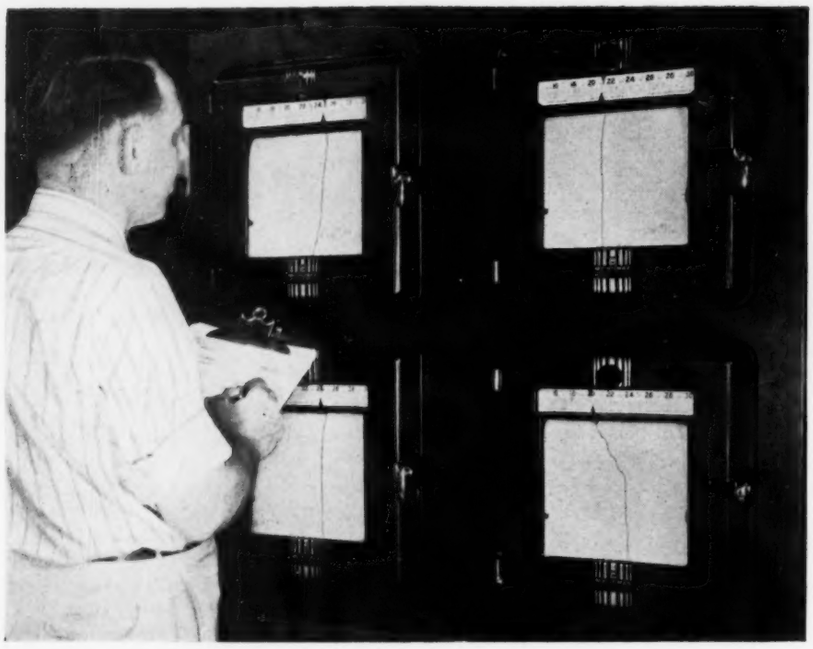
The circular design of Salem Pits materially aids the maintenance of accurate temperature. Salem engineers go still further by adding the same control equipment as that used on outstanding heat treating furnaces: pressure, temperature, and combustion control mechanisms. Hence, circular pits plus heat treating furnace controls, give DOUBLE assurance of heat uniformity at all times. Another advantage lies in the fact that in circular furnaces, only a single thermocouple is required instead of a multiple of them as are found in square type pits.

Salem Circular Ingot Heating Furnaces, with all these worth-while advantages, are built in various sizes to meet any production or building requirement. Remember please, they utilize less space for a given tonnage, and in addition to giving 25% increased production plus greater yield with lower maintenance cost, they also show other big savings.

ADVANTAGES FROM SALEM'S EXPERIENCE

During the designing of Salem Soaking Pits, our engineers were striving for an efficient production method which would give comparable performance to that obtainable from heat treating furnaces. With Salem's broad experience in building furnaces of all kinds as well as steel mill equipment, it is not surprising that its engineers designed and built circular soaking pits that are right now delivering outstanding performance. It is also noteworthy that the world's largest ingot heating furnace was built by Salem. Since experience became the basis for Salem design, and since the design and construction have been substantiated by actual performance records in EVERY Salem installation, you can't go wrong by selecting them. Salem Ingot Furnaces GIVE YOU SIXTEEN DECIDED ADVANTAGES: higher production in a given area, higher heating rate, remarkable heat uniformity, better rolling, better steel, less scale, less chipping, 1% higher yield, a very minimum of cinder, less fuel consumption, no flame impingement on ingots or the furnace wall, no washing of ingots, less maintenance, lower fuel expense, foolproof cover for greater safety, and lower over-all production costs. Here's THE solution to one of your war production problems.

G CO. . . . SALEM, OHIO



Close control of furnace temperature, being maintained by Micromax Pyrometers in plant of Houze Glass Co., Pt. Marion, Pa. Record curves have been strengthened to make them visible, but not otherwise altered

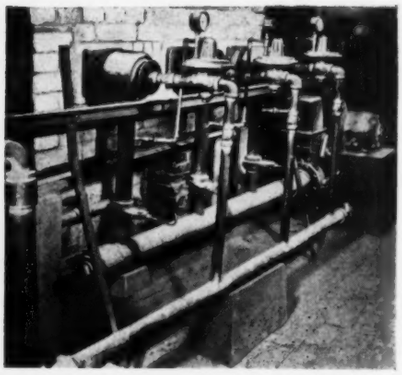
MEN ON THE "FURNACE" FRONT

Are Winning With Micromax Control

The enemies of uniform temperature in the Houze Glass Company's war-busy furnaces are enemies no less than the soldiers of the Axis. They include changes in furnace load; fluctuations in fuel pressure; leaks and infiltration; changes in wind, weather, season, human skill and attentiveness, and all other factors which interfere with a furnace's output.

Houze, however, has vital glass to make, and no enemy or combination of enemies is allowed to stand in the way of production. The furnaces to be regulated are one-ton pot-type units. They are fired with gas, through a burner and manifold in which the volume of gas is held proportional to that of combustion air; air is the fuel element which is actually throttled to regulate temperature.

After considering various throttling plans, Houze engineers decided on the balance type of control — one which measures furnace temperature and balances each change by making a proportional change in air-and-gas. Wanting extremely sensitive and dependable control, they selected Micromax; and the results have more than justified their choice.



Gas and air reach the Houze furnaces through proportional-mixing type burners, arranged in threes. Air-flow is regulated by a Micromax Electric Control valve-drive; gas-flow is held proportional because air-pressure from the header regulates the diaphragm valve in the gas line. A simple set-up which nevertheless enables the Micromax to regulate temperature with utmost dependability.

Even when temperature changes are too small visibly to affect the Micromax, it "feels" them and moves the butterfly air-valve to balance them. The valve seldom moves suddenly or widely, but it is seldom entirely still; it edges up and down — down and up again — holding temperature balance in the narrow band of high-quality, high-production war work.

For further information about this or any other wartime-temperature control problem, ask for engineering service, or for the appropriate catalog.

Fyrestan Tube complete with Ferrule, fitted to L&N PI-181 Couple Head.

QUICK DELIVERY OF TUBES FOR THERMOCOUPLES

To help save metal in the present emergency, we can now supply tubes made of "Fyrestan" ceramic ware, to replace, whenever desirable, the iron, steel and alloy tubes which protect base-metal thermocouples. Fyrestan has long been our standard for temperatures too high for alloys, and we hope that its availability in the alloy range will now give many firms an opportunity to reduce the number of metal tubes they require.

An additional reason for adopting Fyrestan wherever possible is that it can usually be shipped much more promptly than metal tubes.

Fyrestan is of course not as strong as metal, but it is fully as gas-tight. Its life in service is comparable with that of metal, and in some instances, in the range 1800 to 2000 F, it should outlast an alloy. In general, it can be used for all applications except the following:

1. Immersion in molten metals and certain molten salt baths.
2. Where unsupported length exceeds 36 in. vertically or 18 in. horizontally.
3. Where work in furnace may strike tube.
4. Where tube is withdrawn frequently.
5. Where furnace pressure is more than 1 lb per sq in.

When you need tubes, ask about Fyrestan.

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

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Subsidiary Company
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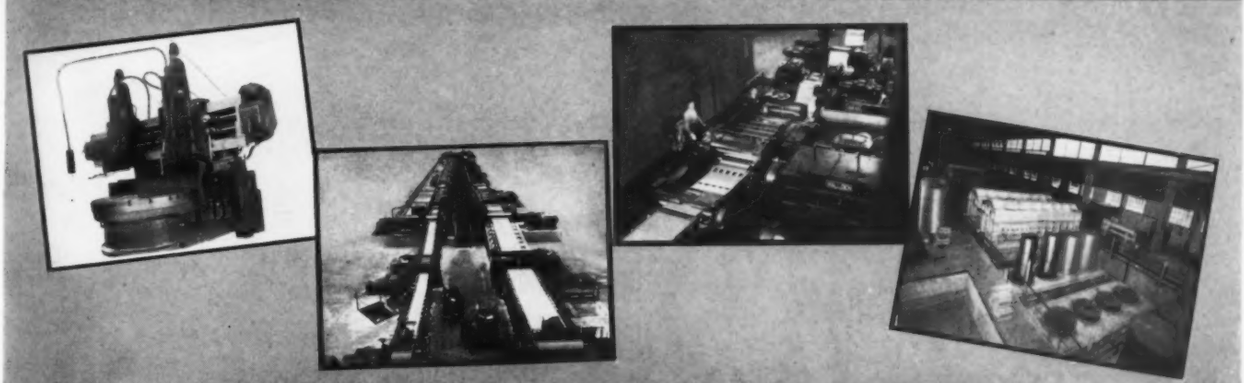


★ ★ SPECIAL MACHINERY for WAR PURPOSES ★ ★

VITAL INFORMATION ON A VITAL NEED

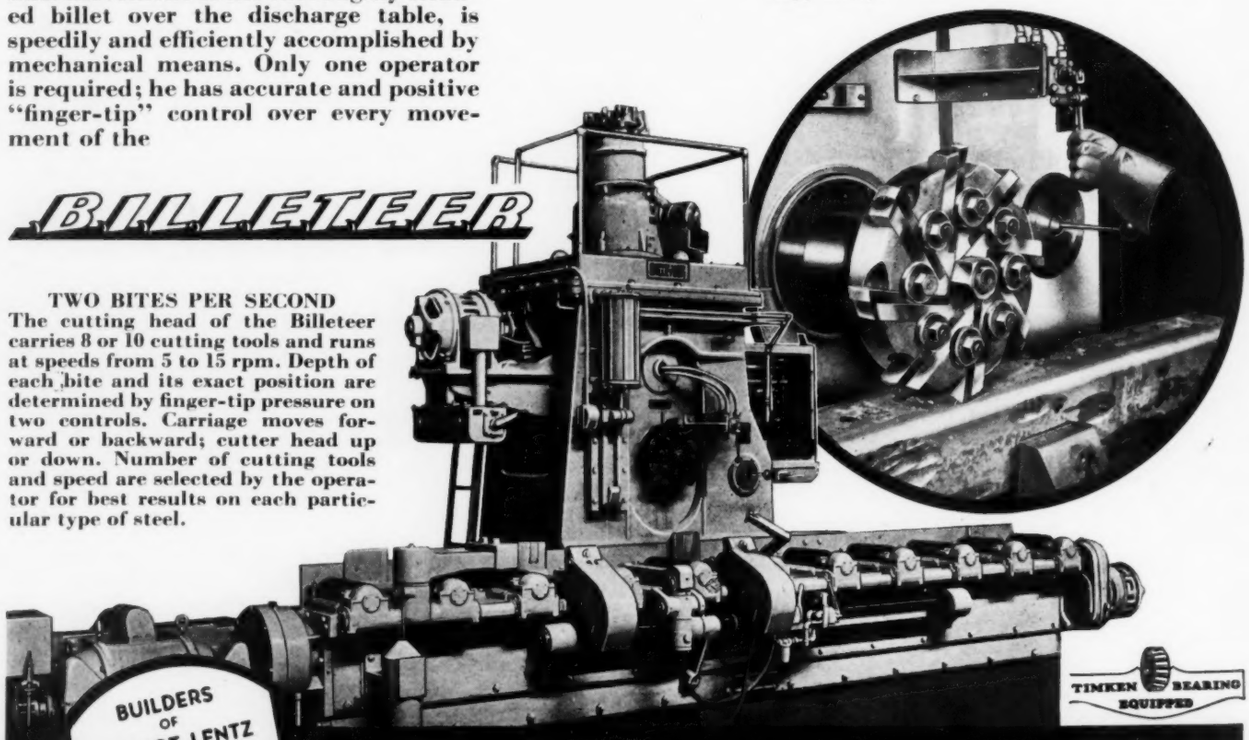
Super quality, quantity, and speed is the production battle cry! No phase of steel production — no department — can lag behind without hindering the Victory effort.

Presented in complete detail in this brochure is a billet-chipping machine that's geared to the times. Every operation, from the instant the operator presses the button that rolls a billet off the feed skids into the machine, to the final movement of the thoroughly cleaned billet over the discharge table, is speedily and efficiently accomplished by mechanical means. Only one operator is required; he has accurate and positive "finger-tip" control over every movement of the

THIS BROCHURE
— shows how you can smash to insignificance the greatest record your Chipping Department ever produced by hand-chipping methods — and in less time with but a fraction of the usual man power! Don't delay — send for your copy today.

BILLETEER

TWO BITES PER SECOND
The cutting head of the Billeteer carries 8 or 10 cutting tools and runs at speeds from 5 to 15 rpm. Depth of each bite and its exact position are determined by finger-tip pressure on two controls. Carriage moves forward or backward; cutter head up or down. Number of cutting tools and speed are selected by the operator for best results on each particular type of steel.



TIMKEN BEARING EQUIPPED

BUILDERS OF BONNOT-LENTZ BILLETEERS ALSO CRUSHING PULVERIZING AND MIXING EQUIPMENT

THE Bonnot COMPANY
STEEL EQUIPMENT DIVISION
CANTON, OHIO

Northern SUPER-CRANES

HEAVY DUTY CRANES *for* STEEL AND METAL INDUSTRIES

Northern Crane handles all material in the storage yard of this steel mill.

Northern Crane, magnet equipped, handling heavy scrap.

Northern Crane handling a variety of materials in steel mill storage

Northern Crane in a Steel Warehouse.

Northern Cranes are working 24 hours a day — 7 days a week in hundreds of plants with no repairs and no shutdowns.

War service is extremely severe, and the pace permits no time for "coddling" a crane. They have to take it — Northern Super-Cranes do.

War pressure is particularly heavy in steel plants, and Northern Super-Cranes in that service are doing an outstanding job.

NORTHERN ENGINEERING WORKS

General Office: **2619 Atwater St., DETROIT, MICH.**

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UNITED'S

New PLATE SHEAR

Fully Equipped to Shear Plates 3/16" to 2" thick.

Cross Cutting or Slitting as desired.

in 8 sizes

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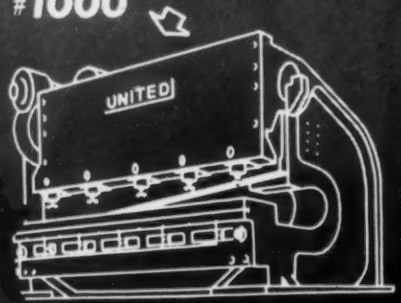

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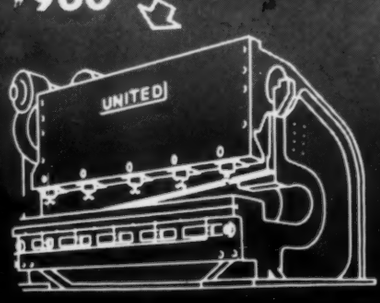

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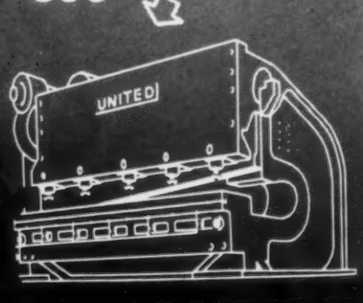

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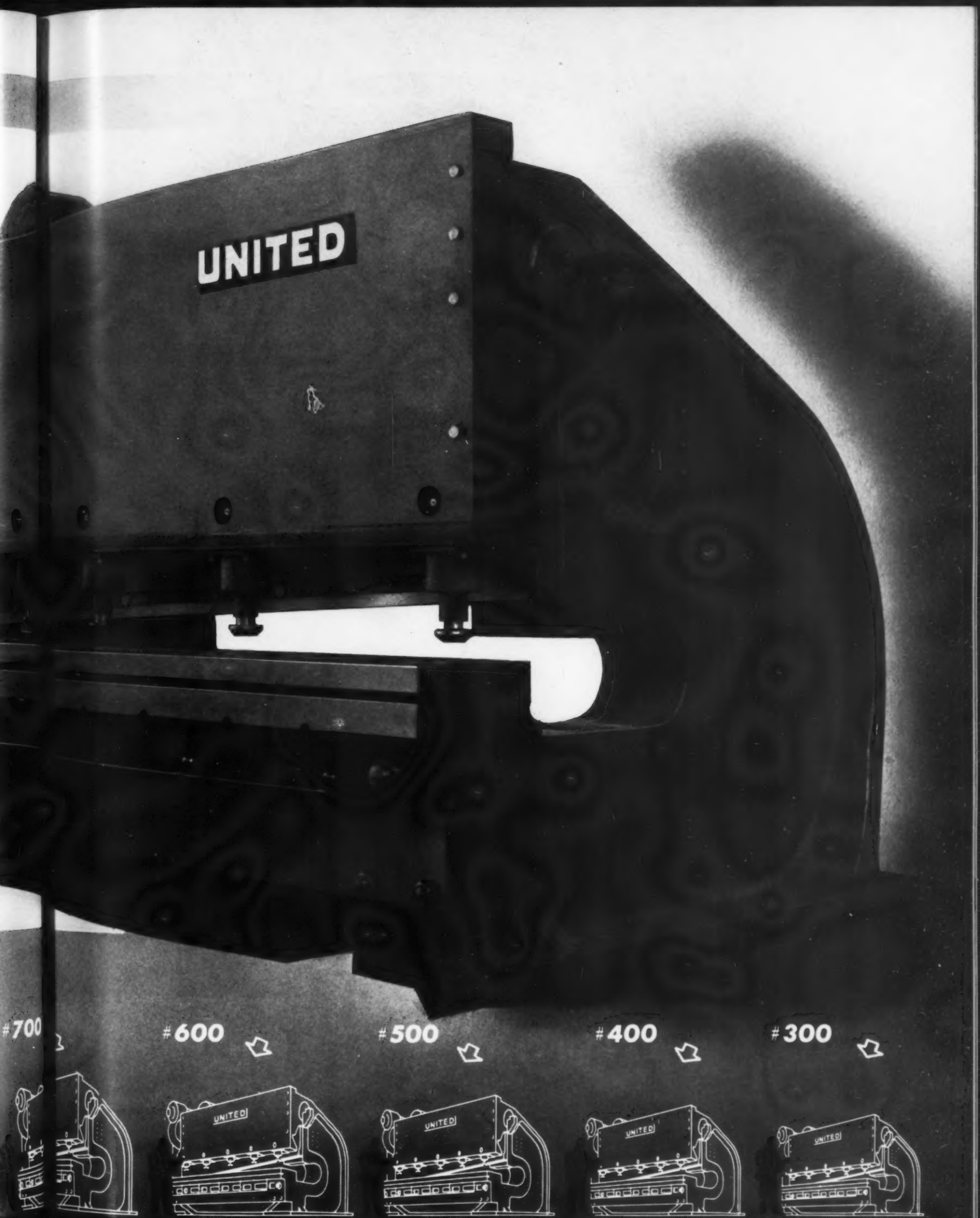
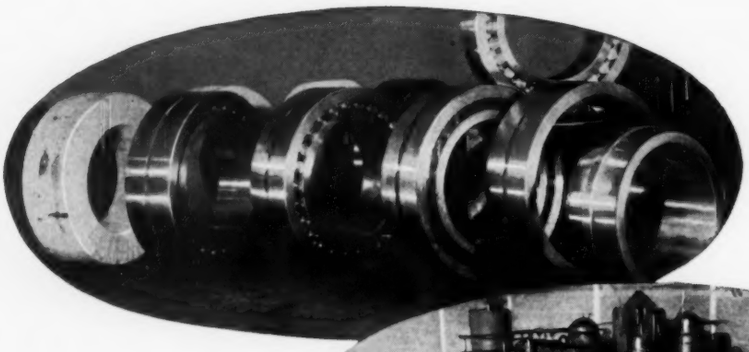
UNITED ENGINEERING and FOUNDRY COMPANY

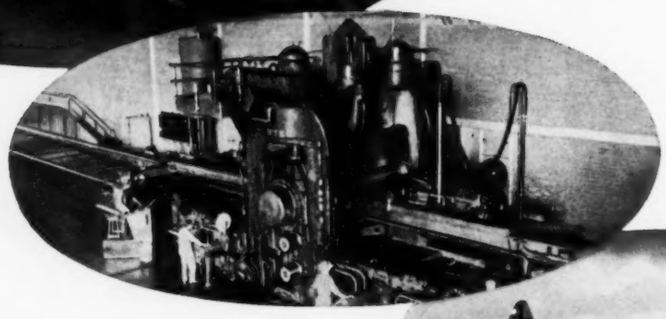


NY PITTSBURGH · PENNSYLVANIA

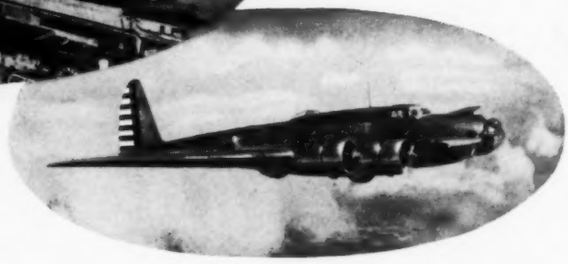
FROM *Bearings* TO *Bombers*



SKF PRODUCTION



SKF's PRODUCING



It takes BIG bearings for the mills that produce the duraluminum needed for the rapidly increasing number of bombers. SKF supplies the BIG Back-up Roll Bearings for the mills running today and for the mills that will be running tomorrow. For instance, SKF has just completed an order, *in record time,* for:

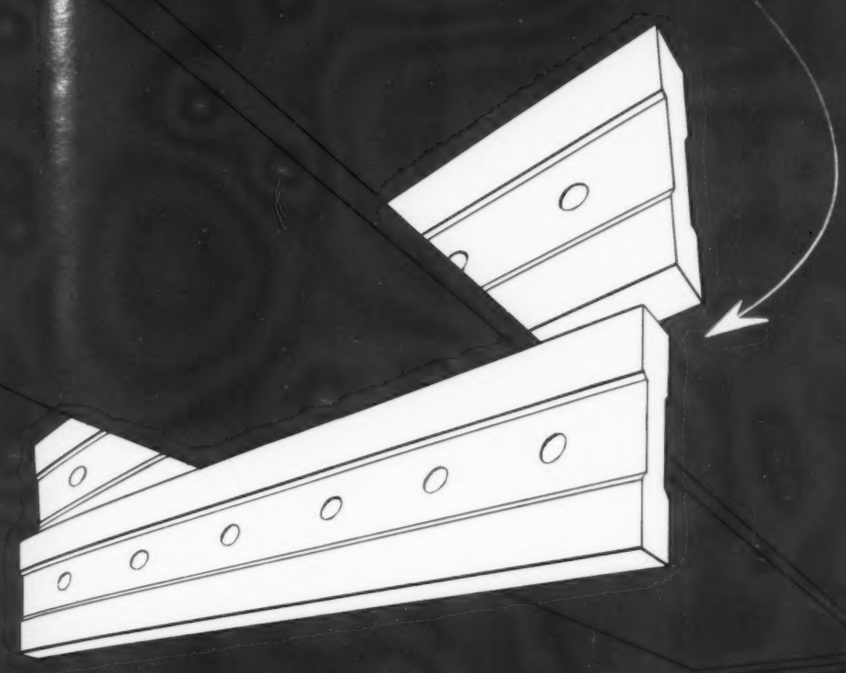
No. Bearings	Bore	O. D.	Width
112	31″	48″	14¾″
92	26″	42″	12⁵⁄₁₆″

This is in addition to 272 SKF Work Roll Bearings ranging in O. D. from 17⁵⁄₁₆″ to 30¾″. Properly authorized persons are urged to send for our new catalog, "Steel Mill Data for Calculation and Design."

5255

SKF INDUSTRIES, INC., PHILADELPHIA, PENNA.

Prompt delivery is vital



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for a war job

Because we make our own E.I.S. alloy steel and have greatly expanded facilities, you can be sure of prompt delivery at a lower rating when you specify Heppenstall Shear Knives. You can be sure of precise manufacture, too . . . their production is controlled by advanced methods, modern equipment, and the skill of many years of experience. *Order Heppenstall Knives, and when you do let us know the shearing job for which they are intended. Let our engineers help specify the proper knife. It's usually false economy to use a knife to cut a thickness or a steel for which it was not designed.*

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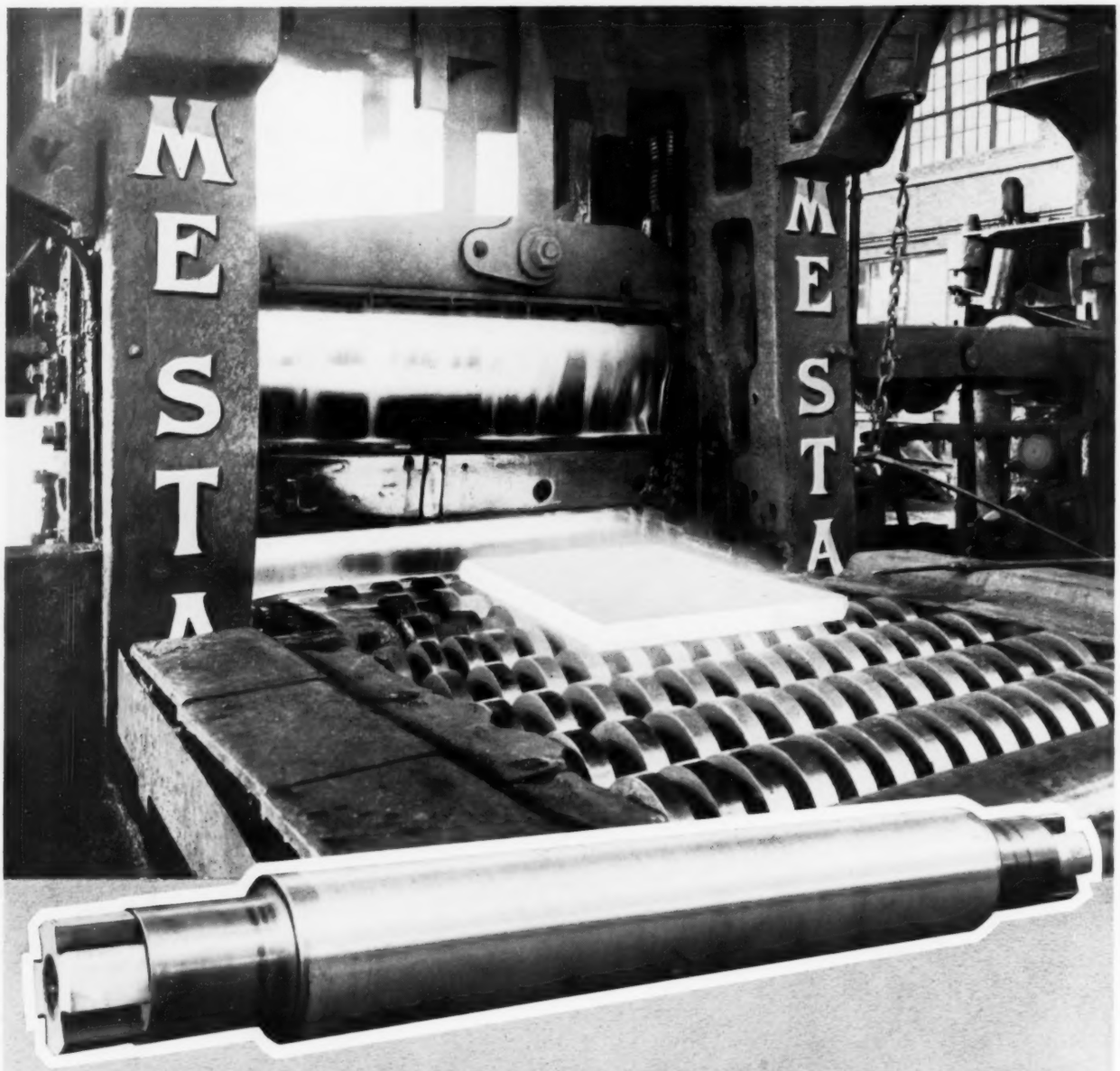


MESTA ROLLS

for

THREE HIGH PLATE MILLS

SMOOTHER SURFACE—LONGER LIFE

The Army-Navy "E" Flag with two stars, flies over the Mesta plant.

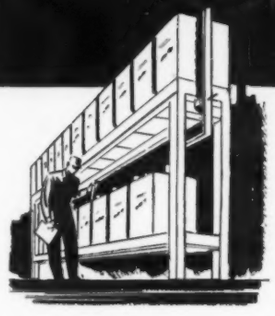
Buy More War Bonds

MESTA MACHINE COMPANY. PITTSBURGH, PA.

PHILCO

THROUGH MODERN DESIGN
BRINGS YOU THIS SENSATIONAL

VITRABLOC STORAGE BATTERY



Philco Floté in Vitrabloc is the most attractive industrial storage battery ever made. Pure white, highly glazed, Vitrabloc brightens dark battery rooms.

FOR CONTROL, STAND-BY AND TELEPHONE SERVICE

Even in peacetime, Philco Vitrabloc would be a tremendous advance in storage battery construction. Today, when batteries must do a bigger job . . . when critical materials are a problem—Vitrabloc is a truly sensational development!

Philco Vitrabloc batteries give you greater capacity without increase in battery space. Vitrabloc incorporates the exclusive Philco Floté principle, the only construction specially designed for modern, full float service. Vitrabloc cells are explosion-proof and spray-proof.

Best of all, no critical materials are used in this vitrified ceramic jar! You can get Philco Vitrabloc batteries on exceptionally low priority!

For advanced engineering and construction in industrial batteries, specify Philco! Call your local Philco Battery representative . . . there's one in every important industrial center!

PHILCO CORPORATION, STORAGE BATTERY DIVISION, TRENTON, NEW JERSEY

REPLACE WITH RUGGED, HIGH-CAPACITY PHILCO BATTERIES

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BLAST FURNACE
CHARGING EQUIPMENT
is now adopted at virtually all new blast furnaces now under construction.
COMPLETE COORDINATED FACILITIES
Skip Hoists • Charging Control
Bell Hoists • Distributor Control
Coke Measurement and Handling
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a quarter century building successful plants
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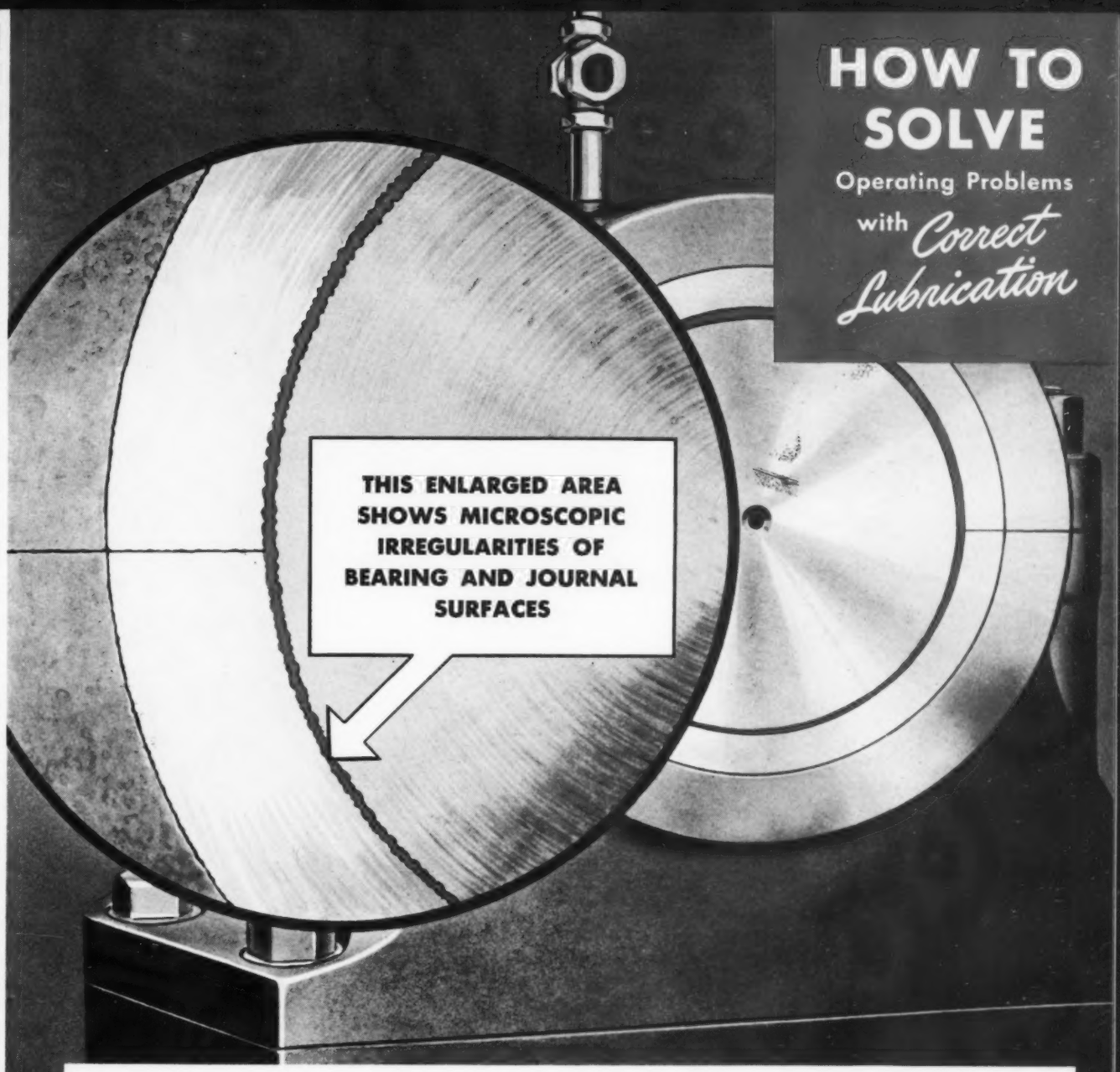
ASHMORE, BENSON, PEASE & CO. LTD., STOCKTON-ON-TEES, ENGLAND.

ONE OF A SERIES OF SUGGESTIONS TO AID PRODUCTION

HOW TO SOLVE

Operating Problems with *Correct Lubrication*



Keep Journals "Floating"

PROBLEM: That's a picture of a simple bearing and journal lubricated by a circulation system. See how their surfaces, so polished to the naked eye, are actually jagged hills and valleys under the microscope! Unless a thick film of oil separates these surfaces the irregularities tend to interlock, cause friction and excessive wear. When bearings are supplied with sufficient oil, rotation of the journal forms an oil wedge thick enough to *actually float the journal.* When deposits in the oil passages prevent adequate oil supply, the oil wedge is destroyed and excessive wear results — and that's the problem in a nutshell.

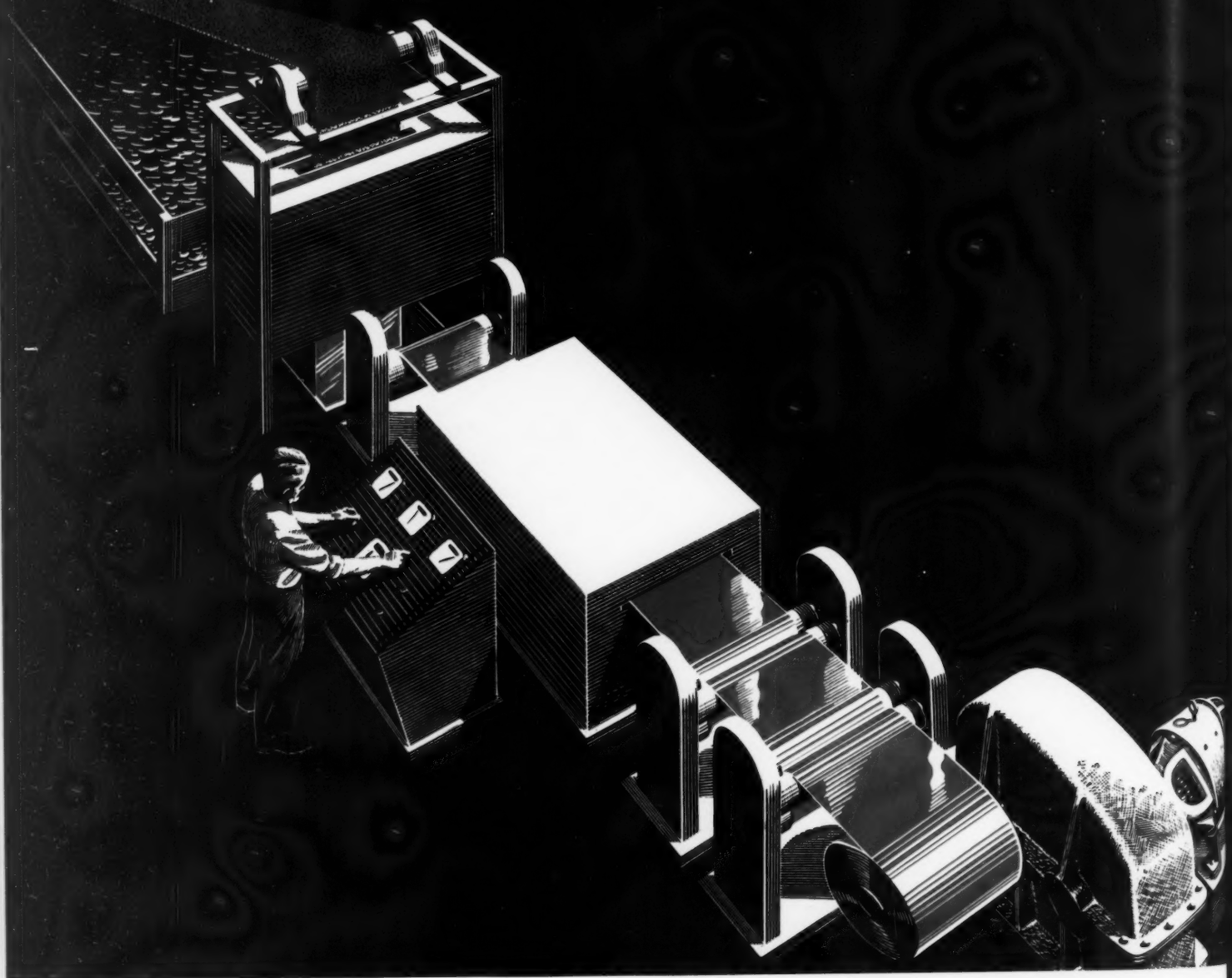
ANSWER: Gargoyle Vacuoline Oils are ideal for circulation-oiled machine bearings. They resist to a maximum the most severe deposit-forming influences and assure continuous oil flow to the bearing.

GARGOYLE Lubricants

SOCONY-VACUUM OIL COMPANY, INC. — Standard Oil of N. Y. Div. • White Star Div. • Lubrite Div. • Chicago Div. White Eagle Div. • Wadhams Div. • Southeastern Div. (Baltimore) • Magnolia Petroleum Co. • General Petroleum Corp.

CALL IN SOCONY-VACUUM

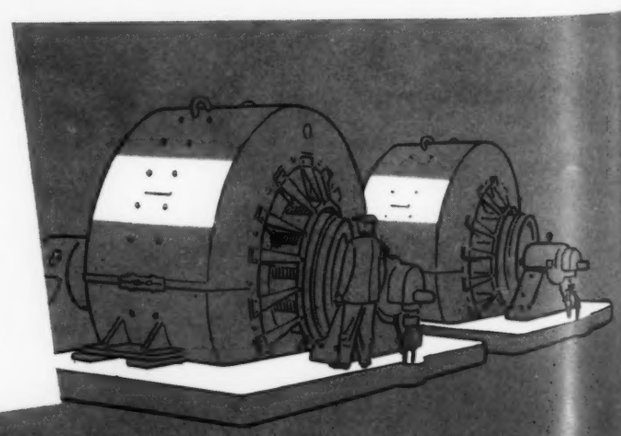
Tons of Tin Saved .



SAFEGUARD MAIN-DRIVE MOTORS

Precipitron—Westinghouse electric air cleaner, provides continuity insurance for main-drive motors and MG sets. By removing all air-borne dirt, dust and soot—including particles as small as 1/250,000 of an inch—this electronic device prevents damaging dirt from settling in windings. Result: increased operating efficiency, with fewer shut-downs for repairs. Write for Booklet B-8605.

Westinghouse



. BY INDUCTION HEATING

"FLOW" PROCESS

For years, most of America's tinplate was made by the "hot dip" process. This took 1½ pounds of tin for every 100 pounds of steel . . . not too much when tin was plentiful.

But when the Japs took Malaya, things changed in a hurry. Tin became a critical material. Vast quantities of tinplate were needed to preserve food for our armed forces. A method had to be found that would not only save tin, but greatly speed production.

Steel engineers developed a way to electroplate steel strip with a coating of tin only *thirty-millionths* of an inch thick—a method which would save two-thirds of our war-scarce tin. But the problem was to "reflow" the granular, dull-gray coating deposited by electrolysis so it would be perfectly smooth and corrosion-resistant—and do it at speeds that would permit greatly increased production.

Westinghouse engineers were called in. Working closely with steel engineers, they developed a method of high-frequency induction heating with electronic control. Within 7/10 of a second after strip enters the heating coil, its fusion temperature of 450 degrees F. is attained. There is no contact between tinplate and heating coil—no danger of arcing or burning. The "flowing" operation is made an integral part of the tinning line, instead of a separate operation requiring additional handling.

600 kw units are now in operation, turning out tinplate at 500 f.p.m.—as compared with 150 to 200 f.p.m. by old methods. 1200 kw units are being built that will step up delivery speeds to 1000 f.p.m.

Soon a large part of U. S. tinplate will be rolling from production lines using this method. Tons of vital tin will be saved—as a result of close co-operation between Westinghouse and steel industry engineers.

This kind of Westinghouse engineering co-operation is available to *you* at any time, in solving any problem involving electrical power. Just phone your nearest Westinghouse office. Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pennsylvania. J-94544

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

WESTINGHOUSE ENGINEERING SERVICE

A nationwide corps of engineers offers you electrical and production experience gained through years of working with the steel industry.

In addition to engineering help on specific industry problems involving electrical power, these men can give you assistance on these other vitally important activities:

PRODUCT DEVELOPMENT: engineering of equipment to meet war requirements.

MAINTENANCE: help in making existing equipment serve better, last longer.

REHABILITATION: redesigning and rebuilding obsolete equipment for useful service.

MATERIAL SUBSTITUTION: adapting available replacements for critical materials.

W.E.S. is available to all branches of the steel industry. Put it to use today on your production problems.

ELECTROLYTIC

The Clark Controller Company has had the distinction of being chosen to supply the Electrical Control apparatus on a total of 28 Continuous Processing lines for the Electrolytic Tin Plate Industry.

Bulletin 101 Type
R. D. Mill Master Switch

13 CONTINUOUS TINNING LINES

2 of these—Continuous Electrolytic Tin Plating Lines—have been in successful operation for approximately five years—the other eleven are under construction at the present time.

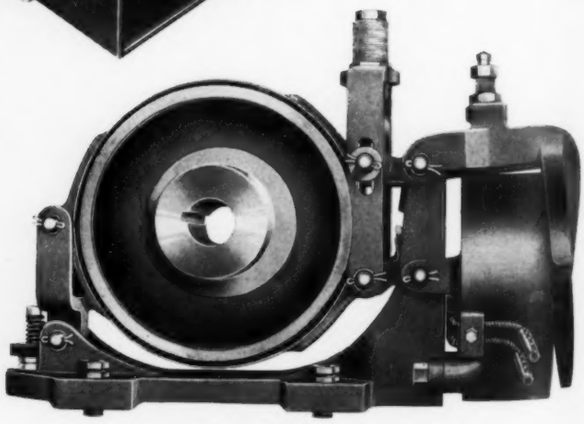
AUXILIARIES TO CONTINUOUS LINES

Pictured on these pages are several types of "3C" apparatus, each designed to deliver maximum service with minimum maintenance.

A "3C" Application Engineer is as near as your telephone.

"3C"
BULLETIN 102
CAM LIMIT
SWITCH

TYPICAL "3C" BENCH BOARD



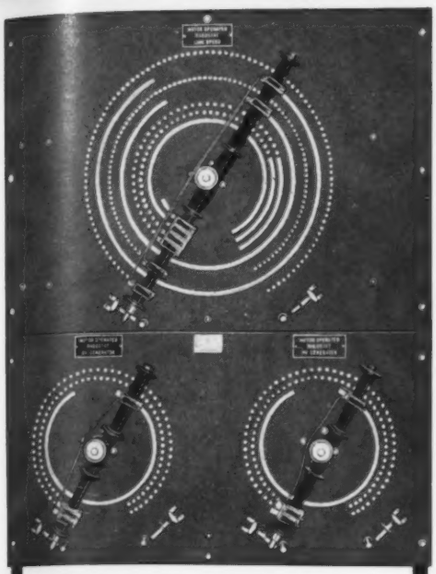
BULLETIN 107 D.C. BRAKE

CONTINUE TO ROLL WITH CLARK CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152ND ST. CLEVELAND, OHIO

TIN PLATING



MOTOR OPERATED RHEOSTAT

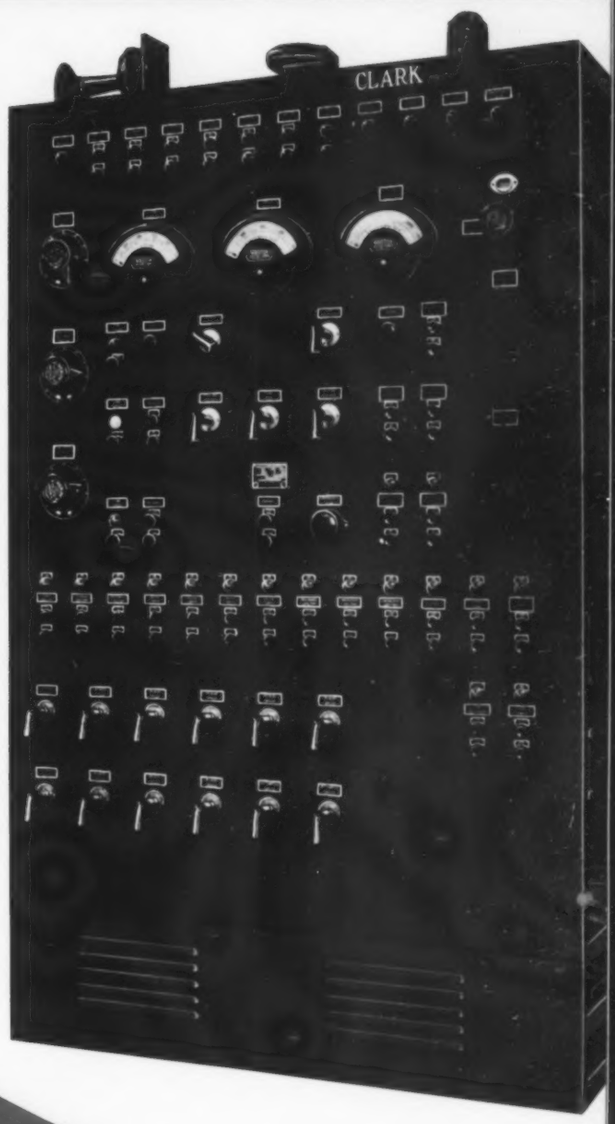
The eyes and ears of an Electrolytic Tin Plate Line are concentrated in the Operator's Central Control Station, A typical section of a "3C" Control Station is shown.

The Siren, Bell and Amber Light, on top of the panel, call attention to overloads or other operational difficulties.

The top row of Pilot Lights indicate whether various functional devices are in proper condition for running the Tinning Line.

Master Switches are operated by Pistol Grips.

Auxiliary motors are started by Push Buttons, with Pilot Lights indicating which motors are running.



9 SIDE TRIMMING LINES

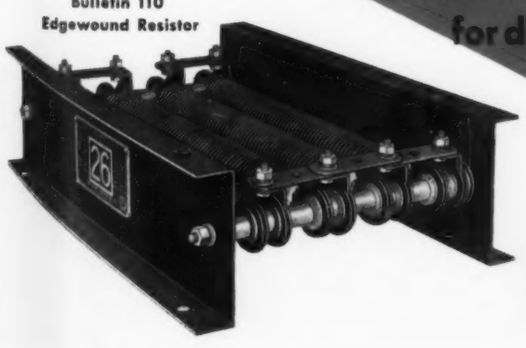
Control for 9 Side Trimming Lines is being manufactured by this company.

6 BRIGHTENING LINES

6 Brightening Lines as well will be equipped with Clark Control.

The Steel Industry is entitled to the highest praise for developing these electrolytic processes. As cooperators with The Reliance Electric & Engineering Co., The Clark Controller Company is proud to contribute its engineering experience and effort to such a vital factor in the Tin Conservation program.

Bulletin 110
Edgewound Resistor



Welded End Terminal
on Edgewound Resistor

CONTINUE TO ROLL WITH CLARK CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152ND ST. CLEVELAND, OHIO

LOOK OUT, you Axis aviators! This bomber is a hornet with a sting on every side . . . protected from attack by blistering fire poured to all points of the compass.

Protection is also important here at home. Guard your equipment and tools to save vital metals . . . cut down needless waste and we can produce more war materials. Storage batteries, for example, last longer when you follow these four simple rules. Obey them all now and you're hitting the Axis. *Buy to Last and Save to Win!*

Exide IRONCLAD BATTERIES

PROTECT YOUR BATTERIES FROM THESE FOUR ANGLES:

1. Keep adding approved water at regular intervals. Most local water is safe. Ask us if yours is safe.
2. Keep the top of the battery and battery container clean and dry at all times. This will assure maximum protection of the inner parts.
3. Keep the battery fully charged—but avoid excessive over-charge. A storage battery will last longer when charged at its proper voltage.
4. Record water additions, voltage, and gravity readings. Don't trust your memory. Write down a complete record of your battery's life history. Compare readings.

If you wish more detailed information, or have a special battery maintenance problem, don't hesitate to write to Exide. We want you to get the long-life built into every Exide Battery. Ask for booklet Form 1982.

THE ELECTRIC STORAGE BATTERY CO., Philadelphia
The World's Largest Manufacturers of Storage Batteries for Every Purpose
Exide Batteries of Canada, Limited, Toronto

HERE'S A *Grid Design* THAT *Insures* EVEN HEAT DISTRIBUTION!

Since each section of the grid is equally exposed to ventilation, heat is evenly and rapidly dissipated. Because this heat is evenly distributed, hot spots are eliminated and long resistor-life assured. For trouble-free service, specify P-G, the Unbreakable Steel Grid Resistor . . . .

P-G

"The Resistor you can Install and Forget"

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

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...and *Pass* THE AMMUNITION!

PASSING AMMUNITION FASTER through production stages . . . speeding it into the hands of America's fighting forces . . . that's a Mathews Conveyer job for the duration! In your plant, if there is any lag in moving materials to and from men or machines, perhaps a Mathews engineer could point the way to improving this condition. Mathews Conveyers are available for critical war materials . . . there is no surer way to shorten the war than to speed Victory at its source!

If you are manufacturing war material, or anything vital to the success of the war effort, you can get Mathews Conveyers to handle that material. Rely as usual on your Mathews Engineer.

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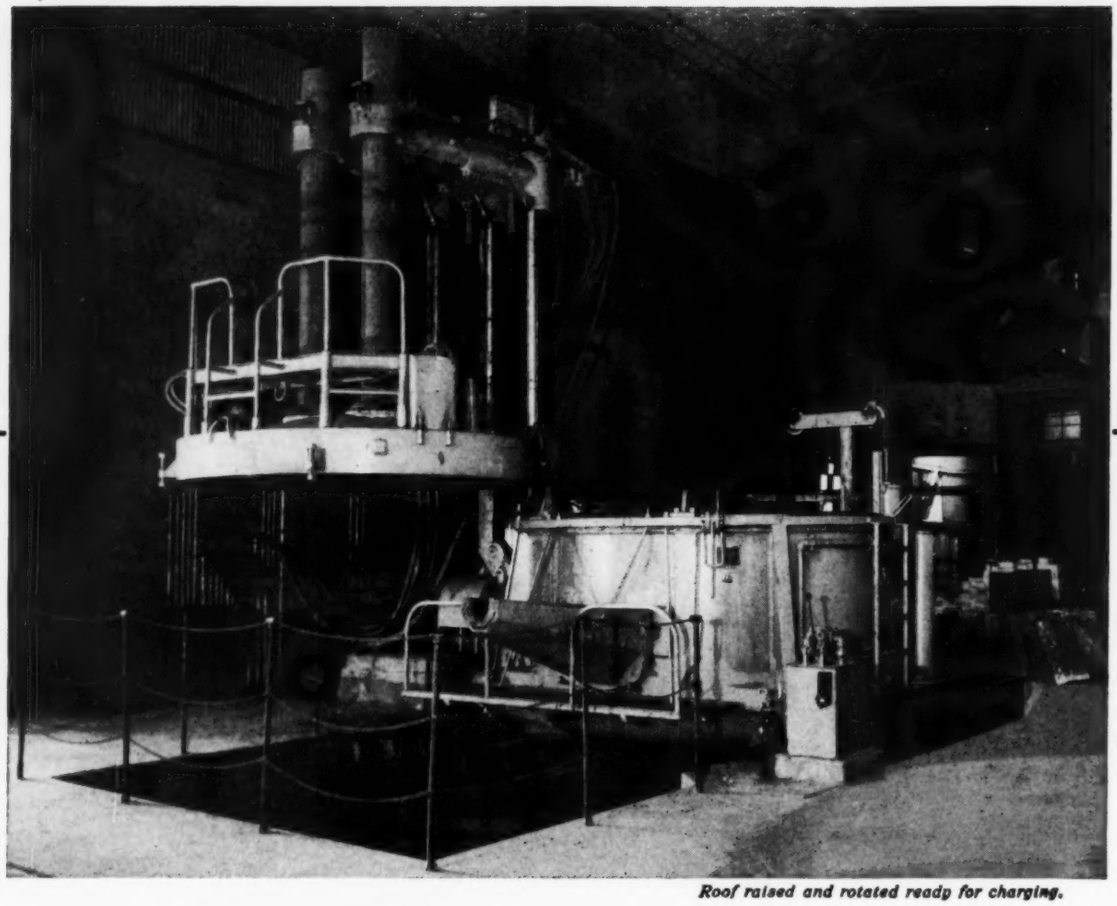

Roof raised and rotated ready for charging.

step UP production
step down costs

THIS top charge type 10 ton Lectromelt furnace is speeding production of alloy steels through its simplicity of design which permits faster charging and greater capacity. Users of top charge Lectromelts are reporting increased tonnage per man hour, lower power consumption and savings in electrodes and refractories. They are built in standard sizes from 100 tons down to 250 pounds capacity.

PITTSBURGH LECTROMELT FURNACE CORPORATION
PITTSBURGH, PENNSYLVANIA

MOORE RAPID *Lectromelt* FURNACES

Electrolytic Tinplating -

. . . . outlining a continuous method of electrolytic tinning, using a sodium stannate bath, as developed in one of the country's pioneer installations . . . .

by WILLIAM COOPER, ELECTRICAL ENGINEER

THE CROWN CORK AND SEAL COMPANY

BALTIMORE, MARYLAND

▲ MUCH has been said and a great deal more will be said about the need for conserving our tin. The industry is making every possible effort to cooperate with the government to substitute tin wherever possible, so I will assume that we are all in accord on this point and that our best chances to accomplish this is by putting less tin on the articles to be coated. The electrolytic deposition of tin meets this requirement without any question, so I will not discourse on the merits of electrolytic tinplate or the advantages of one process over another. However, what I propose to do is to outline to you a continuous method of electrolytically depositing tin on steel strip and a process that uses as its electrolyte the sodium stannate bath.

There is no mystery about electroplating. The art of plating is old; the application of it to present needs is new. Only insofar as adapting it to present day continuous strip does it offer any problems and these are fast disappearing. There are but three factors to be considered: 1 — the handling of the strip, 2 — the proper cleaning of the strip surface, and 3 — the plating of the strip.

Steel for this purpose is received directly from the temper mills in coils of 6000 lb or more and in widths up to 36 in. These coils are placed on runways that lead to uncoilers, there being two uncoilers, one paying out while the other is being charged. This arrangement makes for continuous operation. The strip steel is pulled from these uncoilers by a pair of rubber covered pinch rolls. Between this pair of pinch rolls and the uncoiler is a seam type welder which joins the ending of one coil to the beginning of another.

Following the pinch rolls is a mechanical looping tower which consists of a set of stationary rolls and a set of moving rolls. The moving rolls are mounted on a common carriage free to move vertically. This carriage is counterweighted so that the strip is always under tension. In operation, this looper serves to store strip (approximately 400 ft) in a vertical serpentine manner. This storage is later utilized when making a weld. The counterweight serves two purposes: 1st — to automatically load the looping tower with strip accomplished by overspeeding the pinch rolls, and 2nd — to maintain a uniform back tension throughout the proceeding units. This back tension is essential to maintain perfect tracking as there are no side guides used at either end for this purpose.

The surface of steel strip coming from the temper mills is generally coated with very light oxides. These must be removed just as you would for hot tinning. The bond between steel and tin depends upon the surface to be plated; hence the surface must be chemically cleaned to get best results. This is accomplished by a continuous strip pickling unit using either sulphuric acid or muriatic acid with inhibitors.

The continuous strip pickler used in this process consists of a rubber lined tank 51 in. wide x 12 ft long x 11 ft-6 in. deep and has a series of top and bottom rubber covered rolls mounted in aluminum bronze bearings. The strip travels in a vertical serpentine manner and is acted upon by the acid for 190 ft of its length. At 500 fpm, this would mean a pickling time of approximately 23 seconds. Leaving the pickling tank, the strip

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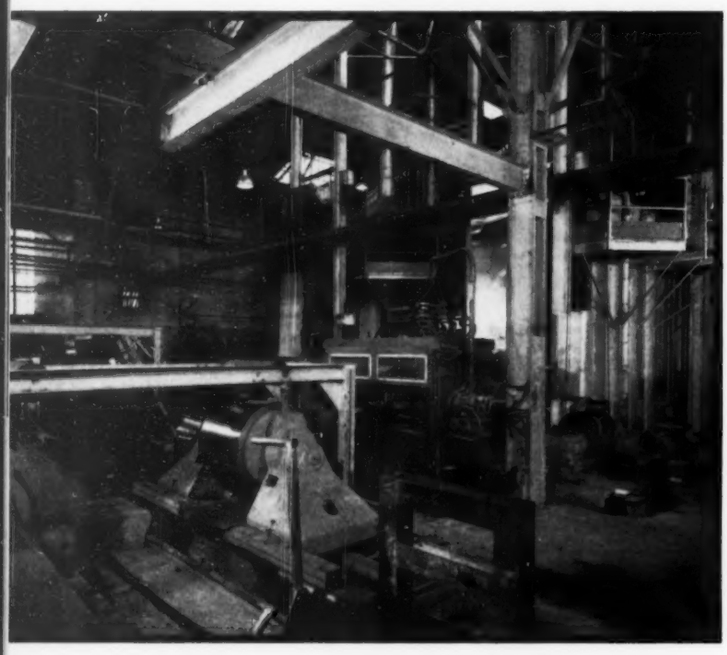
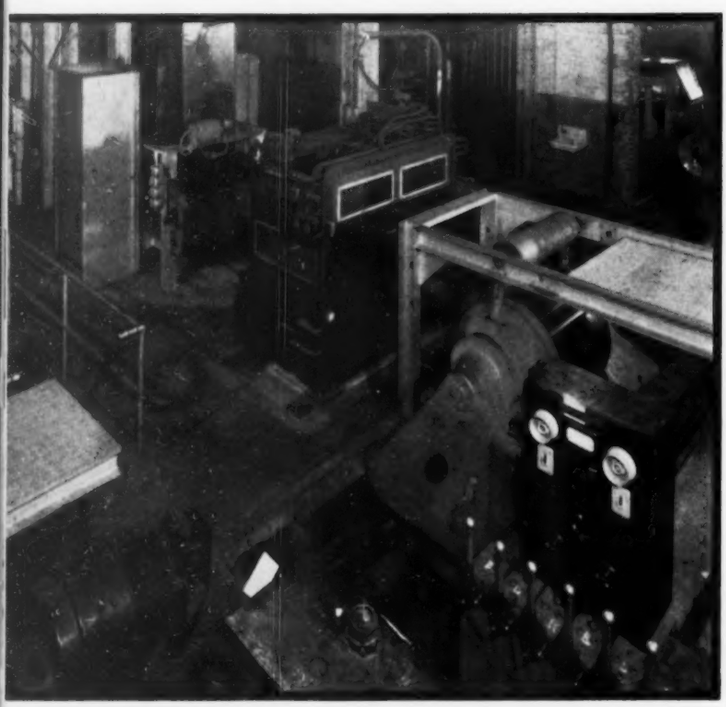
passes through a set of wringer rolls to remove the excess pickling solution from the strip. The strip is then subjected to a cold water rinse to remove any acid adhering to the strip.

Plating takes place in one common cell which is a steel unlined tank 50 ft long x 51 in. wide with a depth of 10 ft and is equipped with heating coils to control the temperature of the electrolyte. The strip travels as in the pickling tank in a vertical serpentine manner and has a capacity of 524 ft of steel strip. Not all this length is acted upon as part is external to the bath.





Figures 1 and 2 — Views of both sides of the entry end of electrolytic tinning unit, showing uncoilers and seam type welding unit.

There are 48 vertical strands of steel and suspended between each strand is a 2300 lb tin anode. These anodes are grouped eight to a 10,000 ampere, 8 volt generator. Current is taken off the cathode by 12 in. steel rolls and is connected to the generator through a specially designed current carrying shoe. These are grouped four to a generator and are capable of carrying approximately 2500 amperes each. Dragout is controlled by a set of wringer rolls and a set of cold water sprays. The cold water is played on the top and bottom of the strip in order to wash away any electrolyte that may be adhering. After plating, the strip is rinsed in hot water to remove any particles of electrolyte that may still be on the surface and is then finally dried by a blast of hot air.

The strip is pulled through the entire line by one master pinch roll, and consists of a 24 in. diameter rubber covered steel roll with two 12 in. snubber rolls. This roll is located immediately after the drying operation and is the only means of pulling the strip and controlling the speed of the line.

Following the master pinch rolls is a delivery looping tower which is a duplicate of that at the entry end and serves to store strip when stripping the finished coil. The coiler is of the collapsible mandrel type and is mounted on a sliding base to permit the coiler to move horizontally, there being no side guides used to control the tracking of the strip. This horizontal motion is the only means of coiling a straight sided coil. The side movement of the strip is received by a roll free to move horizontally. This lateral movement is transmitted to two switches, one on either side of a given center. As the strip moves to one side, the guide roll moves with it making contact with one of the switches. This is transmitted to the sliding base motor and moves the coiler in the same direction as the movement of the strip. This method of strip control is very simple and has proven very satisfactory. Tension of the strip at the coiler is applied by a drag generator and the counterweights of the looping tower. This tension serves to make a tight coil and prevent collapsing after stripping from the mandrel.

The amount of tin deposited is controlled by the speed of the strip, all other conditions remaining the same, that is, applied current, solution level, and chemical balance of the bath. As an illustration, the speed of 350 fpm will deposit .5 lb of tin per base box using 60,000 amperes at 8 volts. At 500 fpm, the coating weight of .3 lb per base box is to be expected.

The plating solution (approximately 15,000 gal) is alkaline and consists of sodium stannate, sodium hydroxide and sodium acetate. The control is very simple, needing only a chemical check once a day. A continuous type filter is used to filter out any particles in suspension and to circulate the electrolyte. The anode current density is kept at 35 amperes per square foot and the cathode current density at 26 amperes per square foot. The efficiency of this process is high — between 95 and 100 per cent.

This process, as I have briefly outlined, has been in operation for some time and has proven to be a sound and practical method of electrodeposition of tin.

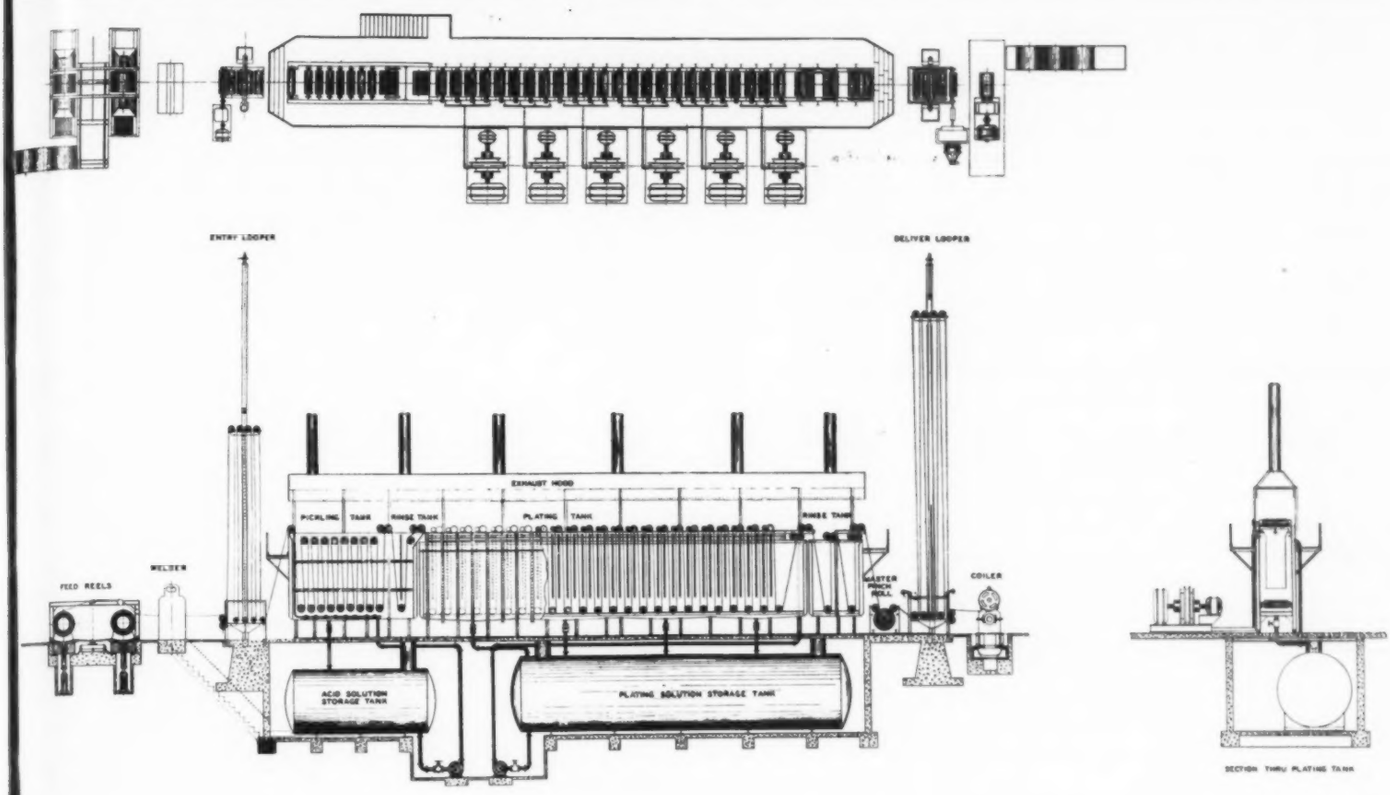
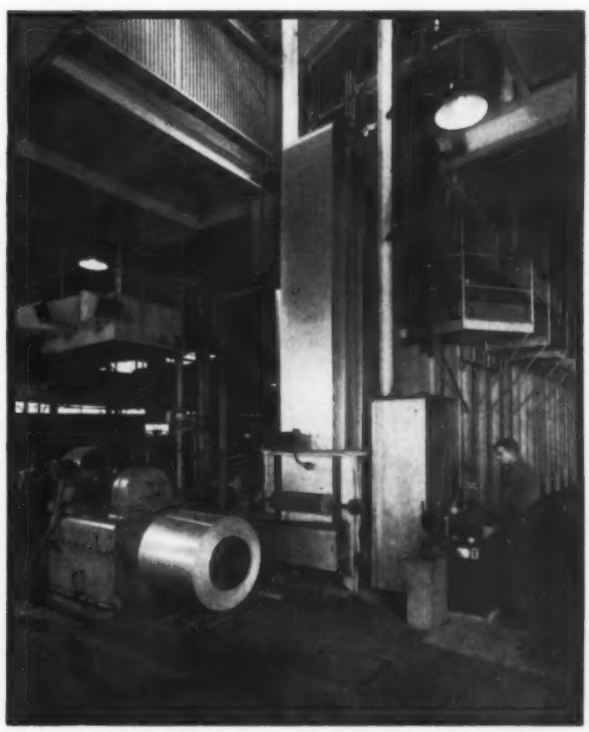


Figure 3 — General arrangement drawing of electrolytic tinning unit.

Strip as plated from this process has a smooth satin finish and can be produced in various coating weights dependent upon its ultimate use. Bottle caps, screw caps, dry packages, can ends and can bodies are being made from this plate. However, some industries still demand the brightened plate and require a further operation of reflowing. Considerable work has been done and is still being done along these lines. We have in

Figures 4 and 5 — Views of both sides of delivery end of tinning unit, showing delivery looping tower and coiler.



operation a continuous reflowing unit that uses radiant tubes to furnish the necessary heat to reflow. One of our large electrical manufacturers has done considerable work in research and is now building a number of high frequency induction units which promise to be one of the solutions to high speed reflowing. Conductance has a place in this picture but is still in the experimental stage. Personally, I feel that resistance heating can be developed to produce satisfactory finishes.

We have a large job before us and that is to conserve tin and at the same time produce a satisfactory product that will preserve our food and beverages. I believe we are equal to the task.

DISCUSSION

PRESENTED BY

E. W. HOPPER, Superintendent Tin Mill, Crucible Steel Company, Midland, Pennsylvania

R. A. GEUDER, Manager, Metal Industries Application, Reliance Electric and Engineering Company, Cleveland, Ohio

H. H. BLOUCH, Development Engineer, DuPont Company, Cleveland, Ohio

R. J. WEAN, President, Wean Engineering Company, Warren, Ohio

E. W. HOPPER: I enjoyed Mr. Cooper's paper very much. After all, there is very little difference when you look the equipment over. Our line at Crucible was the first line designed, the first line in operation. It developed from the work of Dr. Colin G. Fink, at Columbia University, and was based on the acid bath instead of the alkaline bath. That, after all, is the big difference in the two developments. We considered the alkaline bath at that time and decided that in our case, we would prefer to work with the acid bath.

A second difference in the two lines is that instead of plating in the vertical position, on our line in operation at Midland we are using a horizontal tank. We do have a vertical tank out there but it is not in use.

A third difference is that we are brightening and cleaning in the one line. As most people here know, we are brightening in palm oil. We have been doing that since we started production in 1937. The palm oil is removed in a cleaner also of our own design, using a chlorinated hydrocarbon, recovering the palm oil for reuse and ultimate resale.

Instead of using the method that Mr. Cooper has devised of shifting the reels, we have used strip guides, and in our method at the present time we are using hydraulically operated guides, shifting the strip through link action on the rolls. This has also proven very satisfactory and needs very little attention.

In our line, we also have the single bridle stand for pulling through the length of the line, and in addition to that we overdrive with overdriven clutches our contact rolls, and we have found that that eliminates a great many of the scratches which we would ordinarily pick up.

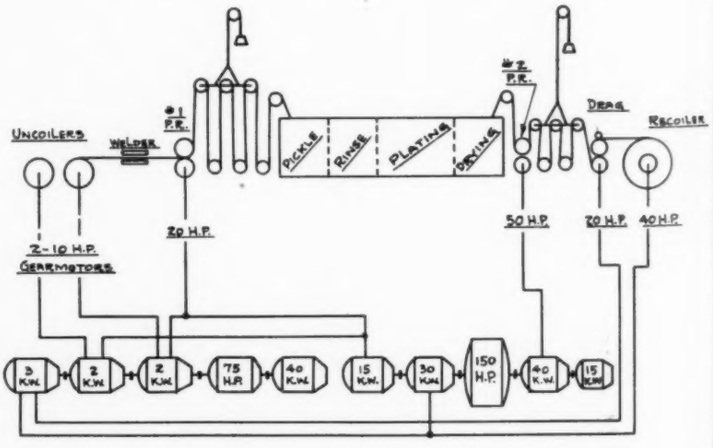
Instead of operating at the elevated temperatures that are necessary in the alkaline bath, we operate at room temperature. Instead of using 60,000 amperes as are necessary in the alkaline bath, the acid bath uses just half of that, due to the higher electrochemical equivalent.

At Midland we have a wind-up motor. We have a motor operating oil squeegee rolls at the end of the oil tank to remove the excess oil. We have a plating drive motor. We have a motor operating a slack producer very similar to that that you just saw in Mr. Cooper's paper. We have our plating motor generator set, and we have a cleaner motor generator. We are doing a little bit of electrolytic cleaning on the line because we do have some problems that are slightly different. It makes a very simple operation. We have been producing tin plate by that method, cleaned and brightened, for five years, and we will probably continue to do that, probably with some expansion at a future date.

R. A. GEUDER: Referring to the accompanying sketch, I would like to point out that from an operating standpoint the loopers that Mr. Cooper mentioned are important. I think we all understand that what is really being attempted is to keep the plating section of the line — the center section — running at a constant speed without the necessity of accelerating or decelerating, and supplying sufficient storage in the entry looper so that as the line continues to run anywhere up to its top speed, the welds can be made while the stored strip is being taken out of this looper.

Similarly at the delivery end, the looper in the normal operating position is at the bottom with no strip stored in it. When the weld is cut out and the new coil is started, the center portion keeps on running and the delivery looper accumulates the strip that is being produced before the recoiler can take it up. The operating men might be interested to know that the operation of the loopers at either end is automatic. That is, the loops develop themselves this way automatically and maintain the storage at the entry end to be ready

Sketch showing general arrangement scheme of electrotinning line, indicating the sections that are connected up electrically.



for the next weld, and the delivery looper maintains itself at the bottom, allowing plenty of room for storage when the weld is being cut out.

The diagram further indicates the several sections that are connected up electrically, the center section being divorced from the entry and delivery sections so it is not influenced by the starting and stopping at either end.

Mr. Cooper did mention current control in that he said that half-pound per base box material could be produced at 350 feet a minute with 60,000 amperes. From an operating standpoint, it seems desirable to have that current relationship between amperes and speed remain fixed. If you want to produce half-pound coating, you would like to have that half-pound coating produced at any speed up to the maximum speed, and all the lines that are going in to have a current control, so that from an operating standpoint you have merely to select the weight of coating in terms of data that you have developed before, and then you may change the speed of the line if you wish and still maintain that same coating.

H. H. BLOUGH: Mr. Cooper has described a very interesting mechanical development. The outstanding feature, to me, of the subject is the tremendous interest and the engineering skill being extended in the development of equipment and processes for the conservation of tin through electrolytic tin plate.

By comparison the actual space and investment in the electroplating part of the line is very small and will probably require a proportionately small amount of attention by the steel industry. In connection with the plating cell it is interesting to note that you may choose between the stannate or alkaline electrolyte, employed by Mr. Cooper, and the acid electrolytes employed by others including the recently announced "Halogen" process.

I would like to suggest further that with a comparatively small expenditure the electrolyte in the plating tanks could be changed and these lines employed for other finishes in peace time, for example, lead, nickel, copper, zinc, etc. I therefore look to the steel industry for interesting developments in electro-coated products during the post war period.

R. J. WEAN: I would like to ask Mr. Hopper at what speed and under what current conditions he has half-pound coating.

E. W. HOPPER: We are limited very much in what we can do at Midland. Our line was originally designed for about 60 feet per minute. We have stepped that up to the point where we have been operating at 200 feet per minute. That is the maximum speed we could operate because if we went after it any faster we would tear it apart.

We have been operating from half pound — actually, from about a quarter-pound — up to a pound and a half tin plate. We have been operating up to cathode densities of about 80 amperes per square foot and anode densities of pretty much the same. We generally try to keep it lower; on the half-pound tin plate we do keep it lower. We keep it around 50 amperes per square foot.

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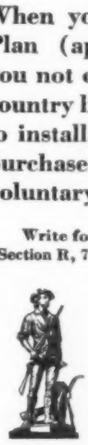

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Electrical Equipment for CONTINUOUS ELECTROLYTIC Tinplating

. . . . the development of electrolytic tinning processes has imposed new problems in the application of drives, control, conversion apparatus, and other electrical equipment . . . .

by J. H. HOPPER

INDUSTRIAL ENGINEERING DEPARTMENT

GENERAL ELECTRIC COMPANY

SCHENECTADY, NEW YORK

▲ IT IS indeed fortunate for us all that there are men in the steel industry and others indirectly connected with this industry, who had the vision and the courage to spend a great deal of money on the development of processes for making electrolytic tinplate many years before Pearl Harbor and Singapore became dark chapters in our history, and we awoke to find our enemies firmly encamped on over 80 per cent of the world's tin supply. Even so, the infant electrolytic tinning industry was forced into maturity almost overnight by the desperate necessity of conserving our dwindling stocks of tin.

A year ago, there were in this country two continuous tinplating lines capable of handling strip 30 inches wide at maximum speeds of about 300 fpm, one 20 inch line good for about 200 fpm, and several smaller lines which were built and used primarily for experimental purposes. Today, there are built, or on order about 26 new lines, most of them designed to handle 36 inch strip at 500 to 650 fpm. In fact, on several lines provisions are included to boost the speed to 1000 fpm as soon as we learn how to make a satisfactory product at that speed. Most of the new lines should be in operation before mid-1943.

The annual capacity of one of these new high speed lines has been variously estimated at 1½ to 2½ million base boxes. It is also reliably estimated that 50 per cent of the tinplate made in this country in 1943 (or about 30,000,000 base boxes) will be the electrolytic product. Any further restrictions which may be imposed on the use of hot dip tinplate will automatically increase the amount of electrolytic tinplate which must be made.

The basic reason, of course, for the shift to electrolytic tinplate is the very substantial saving in tin. It is said that electrolytic tinplate, with ½ lb of tin per base box (.00003 inches thick) is for many purposes a satisfactory substitute for hot dip tinplate with 1¼ to 1½ lb per base box. It is apparently not practical to make the hot dipped product with a coating lighter than 1¼ lb per base box. Therefore, we are saving at least ¾ lb of precious tin on every base box of electrolytic tinplate which can be substituted for the hot dipped product. The economics of this situation would be sufficient justification for the electrolytic process, but the present strategic value of tin is so great that economic considerations are dwarfed by comparison.

A number of articles and papers have been written about electrolytic tinning, and it is not the purpose of this paper to discuss any of the debatable claims of those who may have other than purely academic interest in the subject.

For a general discussion of the complete subject, we recommend T. W. Lippert's article which appeared in

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the April 30, 1942, issue of *The Iron Age* under the subject "Food in Cans."

During the development stages of electrolytic tinning, there was apparently not much attention paid to the selection of electric equipment. This is an entirely natural condition on experimental equipments, and no criticism is implied. However, with the advent of the full width, high speed continuous tinning line as a production unit, it became very important to get the right type of motors, control, motor-generator sets, switchgear and conversion equipment to do the job on a production basis. It is very desirable, of course, to have one electrical manufacturer with a good background in application and coordination of the various types of electric equipment, to be the supplier and coordinator of all electric equipment used in connection with any one tinning line installation. In this way, the purchaser obtains the services of the best qualified application engineering talent available, to coordinate the various components of electric equipment, and also avoids any possibility of divided responsibility in the future.

In discussing the selection of electric equipment, we shall confine ourselves to three basic designs of tinning lines, since all of the lines now being installed are based on these three designs. There are other lines in existence, both for developmental and production purposes, which may be just as good or better than any of these three designs, but we shall confine our remarks to the three types of lines now being installed by a large number of tinplate producers.

Let us first consider the types of driving motors and control which are best suited for uncoiling, pulling the strip through the line, and either recoiling or shearing into sheets as the case may be.

Figure 1 illustrates diagrammatically a vertical longitudinal cross section of one popular design of tinning line, and also shows the recommended power circuits for the d-c driving motors. This type of line was developed by the Crown Cork and Seal Company of Baltimore. Briefly, this line operates as follows: Two cone type uncoilers are provided to save time in welding the tail end of one coil to the front of the succeeding coil. The double seam welder is of conventional design. The entry pinch roll pulls the strip from the uncoiler against a slight back tension maintained by the uncoiler ma-

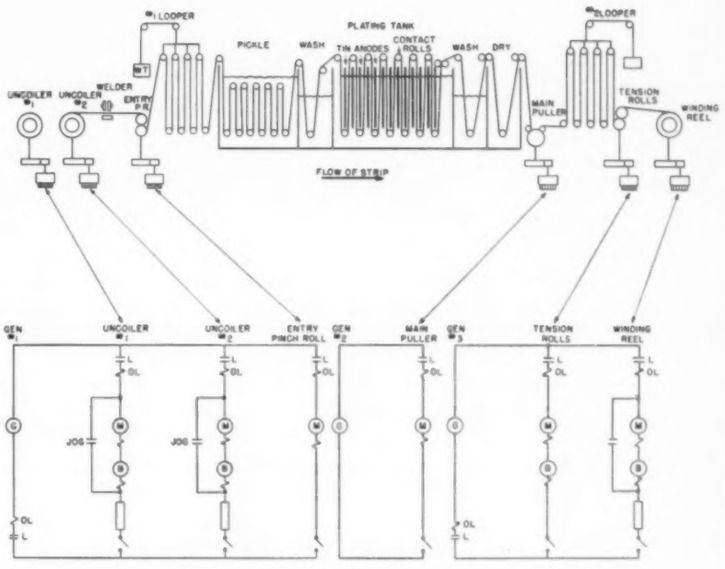
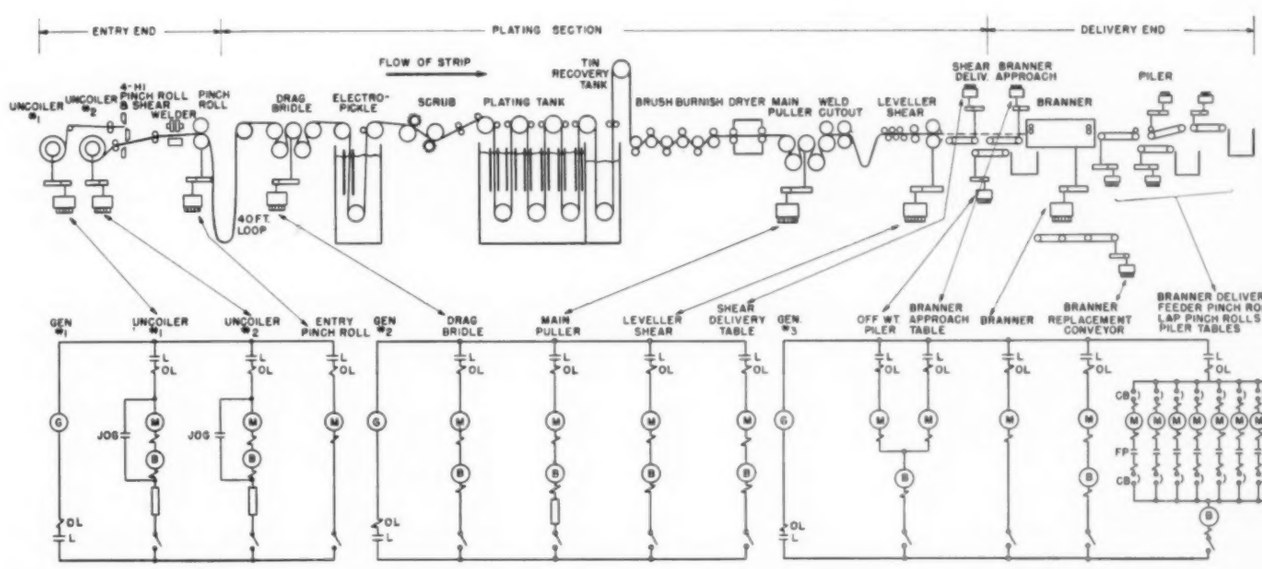


Figure 1 — General arrangement of electrolytic tinning line developed by Crown Cork and Seal Company, with d-c driving motor circuits.

Figure 2 — Electrolytic tinning line developed by Carnegie-Illinois Steel Corporation, with scheme for d-c driving motor circuits.



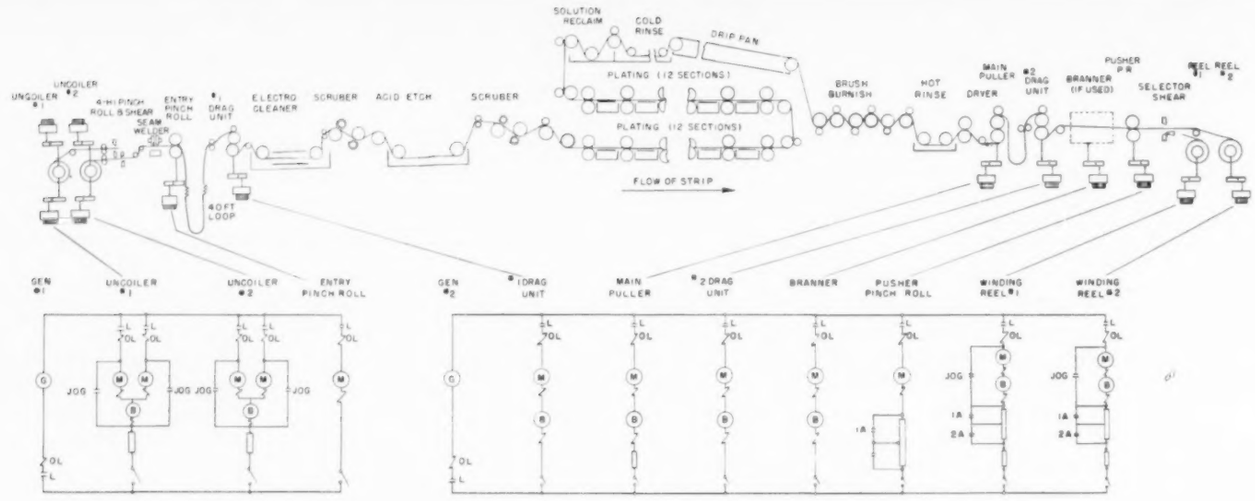
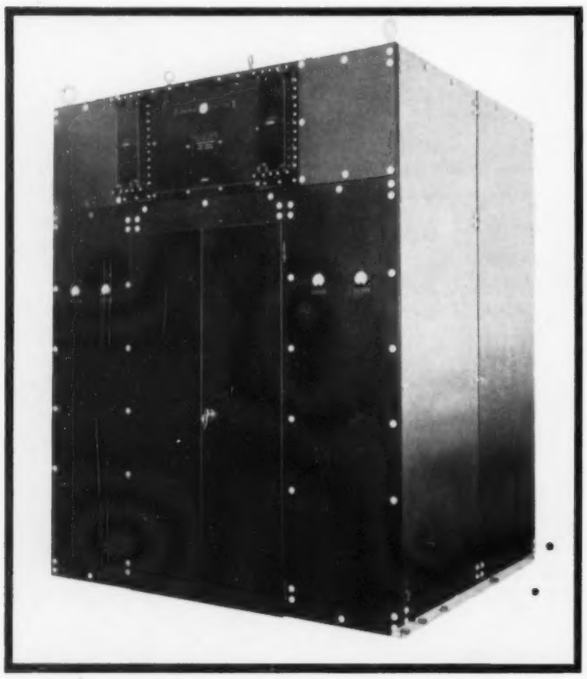


Figure 3 — Circuit for d-c driving motors recommended for electrolytic line developed by United Engineering and Foundry Company.

Figure 4 — Enclosed copper-oxide rectifier for steel plant tinplating service, rated at 9 volts, 5000 amp.



chines acting as drag generators, and delivers the strip to the No. 1 looper, which is merely a mechanical strip storage device, which allows the line to keep running while the front end is down for changing coils. The strip then passes through an acid pickling process, a wash, through the plating tank in 48 vertical passes, through another wash and a dryer to the main puller bridle rolls. The main puller pulls the strip through the tanks from the No. 1 looper and delivers it to the No. 2 looper, which provides a storage space for strip to accumulate while the winding reel is being stripped and rethreaded. The tension rolls and winding reel are conventional types, except that there is no free loop ahead of the tension rolls, as is usually the case for the purpose of guiding the strip. Instead, the complete reel mechanism and motor floats back and forth, and by suitable automatic control is made to follow all the minor lateral movements of the strip as it comes from the back tension rolls. This feature will be discussed later in more detail.

Types of motors and control — D-c driving motors are selected for this type of line because:

1. A wide range of operating speeds is required.
2. Accurate speed control must be maintained between the various driving motors.
3. Provision must be made for coil build-up on the reel and build-down on the uncoilers.
4. Tension control is essential on the reel and desirable on the uncoiler end.

Adjustable voltage or "Ward Leonard" control for the d-c motors is selected because:

1. The speed range required (10:1 or more) is too great for motor field control to be practical.
2. Motor starting resistors and contactors are eliminated.
3. Less expensive constant speed motors can be used.
4. The control is simplified.
5. Control maintenance is reduced.
6. Overall cost is only slightly more.
7. Dynamic braking can be eliminated.

Separate adjustable voltage generators were provided for the three sections of the line, as indicated, because:

1. Both ends of the line must start and stop independently, and the use of separate generators avoids the necessity of starting resistors and contactors.
2. The two ends of the line must have speed adjustments independent of the central part of the line, in order to fill up or empty the loopers when the line is running; and yet the motors on each section (i.e. tension roll and reel motors) must maintain

accurate speed relationship in order to maintain constant tension between these points.

3. Quick, smooth acceleration and deceleration is obtained while maintaining the proper tension between drives.
4. Dynamic braking to stop becomes unnecessary, because regenerative braking is readily obtained.
5. Smaller generators can be furnished in a higher speed set with a less expensive motor. Overall cost, including control is about equal for one large generator or three smaller ones.

Except for the uncoiler and winding reel motors, which have to be variable speed motors, we recommend standard constant speed industrial type motors with the addition of drip covers for this application. Although there are many places in a mill where motors of this type are not considered suitable, this job is somewhat similar to cleaning lines, shearing lines, etc. where they are commonly used with entire satisfaction. Also, the pioneer tinning lines have operated several years with motors of this type with entire satisfaction.

Horsepower requirements — It is very difficult to calculate or properly estimate the horsepower requirements for driving a line of this nature until we get a considerable amount of actual operating data. The load is practically all friction and many of the bearings are running submerged in a hot plating solution or in acid, which makes that part of the load a rather doubtful quantity. Therefore, let us begin at the delivery end where we are on more familiar ground and can calculate the requirements rather easily. Assume a maximum speed on this end of the line of 600 fpm, a maximum strip width of 36 inches, a maximum strip thickness of .012 inches, and a gear efficiency of 85 per cent on the reel. We know from experience and operating data on cleaning lines that we need from 3000 to 4000 psi tension to wind a first class coil; let us use 4000. Therefore, the maximum horsepower required will be:

$$\frac{4000 \times .012 \times 36 \times 600}{33{,}000 \times .85} = 37.1 \text{ hp}$$

We would, therefore, recommend a 40 hp motor. If the maximum coil buildup is 20 in. inside diameter x 48 in. outside diameter, a motor with a 3 to 1 speed range would be indicated, say a 500/1500 rpm motor.

Let us next consider the tension roll machine, which will function as a drag generator. Except for the little help which it gets from the No. 2 looper this machine must pump back the output of the reel motor less the mechanical losses in the reel and tension rolls less electrical losses in the tension roll drag generator. Assuming 85 per cent for each gear efficiency, 90 per cent electrical efficiency, and neglecting other minor mechanical losses, we arrive at:

$$40 \text{ hp} \times .85 \times .85 \times .90 \times .746 = 19.4 \text{ kw}$$

We would, therefore, normally select a machine having a drag generator rating of 20 kw. However, if a counter-weight of 3000 lb is to be used on the No. 2 looper, this is equivalent to about 5 kw of drag at 600 fpm; and in this case a 15 kw machine should be adequate on the tension rolls. Generator No. 3 must take care of the difference between input to the reel and output from the tension roll drag generator, plus some additional capacity to take care of accelerating both units. Assuming 90 per cent electrical efficiency of reel motor, we calculate:

$$\frac{40}{.9} \times .746 - 19.4 = 13.8 \text{ kw}$$

We would normally recommend a 25 kw generator here, to allow for considerable variation in the assumed

Figure 5 — General arrangement of 45 kw, 5000 amp, 9 volt rectifier unit.

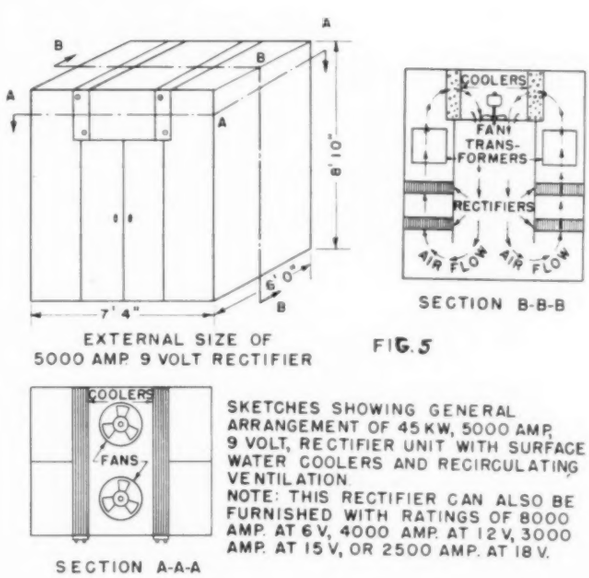
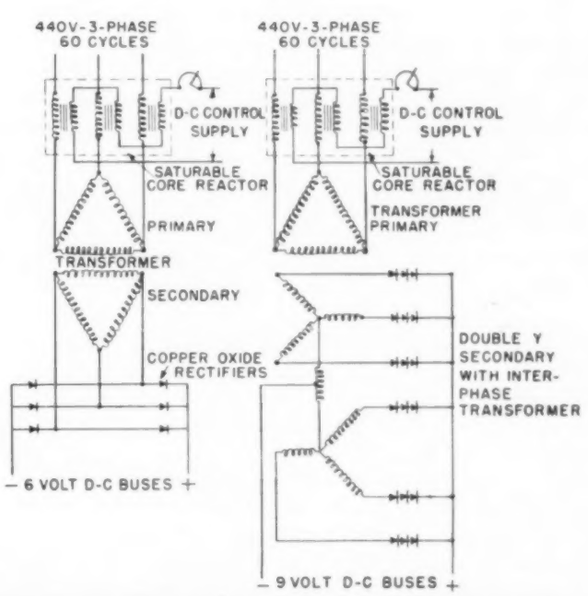
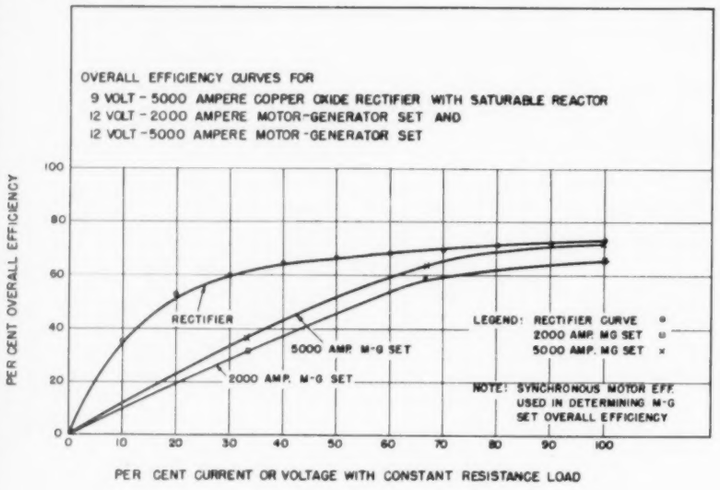


FIG. 5

Figure 6 — Fundamentals of transformer connections for 6 volts and 9 volts direct current.

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12 VOLT - 5000 AMPERE MOTOR-GENERATOR SET
PER CENT OVERALL EFFICIENCY
100
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RECTIFIER
5000 AMP. M-G SET
2000 AMP. M-G SET
LEGEND: RECTIFIER CURVE ○
2000 AMP. MG SET □
5000 AMP. MG SET ×
NOTE: SYNCHRONOUS MOTOR EFF. USED IN DETERMINING M-G SET OVERALL EFFICIENCY
0 10 20 30 40 50 60 70 80 90 100
PER CENT CURRENT OR VOLTAGE WITH CONSTANT RESISTANCE LOAD

Figure 7 — Curves showing overall efficiencies for 9 volt, 5000 amp copper oxide rectifier with saturable reactor, and for 12 volt motor-generator sets of 2000 and 5000 amp rating.

gear efficiencies, and also to allow for rapid acceleration and deceleration.

In selecting a motor for the main puller, we estimate the friction load from data taken on a similar line with two-thirds the number of rolls and operating at 300 fpm with 30 inch strip. The actual requirement on the slower speed line was about 15 hp. Therefore, for a 500 fpm, 36 inch line, we estimate:

$$15 \times \frac{500}{300} \times \frac{24}{16} \times \frac{36}{30} = 45 \text{ hp}$$

We would, therefore, recommend a 50 hp motor, driven from a 50 kw generator (Generator No. 2).

On the entry end of the line, the application of drag generators on the uncoilers is similar to that on many cleaning lines. Based on experience with such lines, we would select a 7½ kw drag generator for each uncoiler, or perhaps two 5 kw machines if one is to be used on each cone. Speed range will be 3:1 or 4:1 depending on ratio of coil diameters.

The entry pinch roll motor should be large enough to pull the maximum pump back on the uncoiler machines plus mechanical losses in both gears plus electrical losses in the uncoiler machines, or:

$$\frac{7.5}{.746 \times .85 \times .85 \times .85} = 16.4 \text{ hp}$$

We would, therefore, select a 20 hp motor in this case in order to be sure of enough capacity to provide snappy acceleration.

The No. 1 generator will not have much load under constant speed operating conditions but must be able to commutate the heavy currents involved in accelerating a coil weighing perhaps 15 tons. We would, therefore, select a 20 kw generator to allow ample capacity to commutate all the current which the entry pinch roll motor will take plus perhaps some motor load from the uncoiler machine during accelerating peaks.

CARNEGIE-ILLINOIS TYPE OF LINE

Figure 2 illustrates diagrammatically a tinning line of the type developed by the Carnegie-Illinois Steel Corporation. A number of these are now being installed in the Chicago, Pittsburgh, and Birmingham areas. The original 30 inch line, which was built mainly for experimental purposes, is still in operation at Gary, Indiana, and is turning out tinplate on a production basis. This original line was slow speed at first, but has been speeded up several times, and I understand now operates at about 300 fpm. The new lines are expected to do 600 fpm eventually, and will handle strip up to 36 inches wide.

Two uncoilers for alternate coils are also used on this line, followed by a small 4-high pinch roll, a shear, a seam welder, and the entry pinch roll which feeds the strip into a deep looping pit, and thus provides strip storage to keep the line running while welding coils together. This loop also provides a convenient place to guide the strip as it enters the main part of the line. Next is the drag bridle for holding back tension on the strip as it passes through the electrolytic pickling tank, a washing operation, electrolytic plating tanks, tin recovery tank, brush burnishing with metallic brushes, and steam dryer to the main puller bridle stand. Following this is the shear for cutting out the lap weld, followed by a short loop ahead of the more or less conventional leveler shear where the strip is cut into sheets. From here the sheets pass by a deflector gate which throws "off gauge" sheets and sheets containing pinholes into the "off gauge piler." The branner is next in line, and is followed by a system of rolls and conveyor belts which convey the prime sheets to either of two piles. All this part of the equipment is of somewhat conventional design. The branner is arranged so that it can be removed from the line and replaced by a section of conveyor.

Adjustable voltage d-c drives were selected for this type of line for the same reasons tabulated in the discussion of the previous line.

1. A separate generator is desirable for the entry end because this section must stop from making a weld, while the main part of the line continues to run at reduced speed. Magnetic acceleration and dynamic braking are thus eliminated, and improved performance is also obtained.
2. The drag bridle, main puller, and leveler shear, should all be on the same generator because it is necessary to maintain a constant speed relationship between these machines.
3. The branner and the various sheet handling equipments at the delivery end should be on a third generator since it is not necessary to maintain accurate speed matching between this section of the line and the preceding section. Also, it may be desirable to run this section at a somewhat higher relative speed, when the preceding section is down to the minimum operating speed, in order to assure proper operation of the branner.

It will be noted that a number of small motors on the delivery end of this line have been grouped on one adjustable voltage controller with individual motor protective devices. This provides a considerable saving both in cost and floor space. This has been common practice for some time on such applications as hot strip mill d-c runout tables.

The same methods of approach as used on the line previously discussed, also apply when selecting the horsepower requirements for this line. Therefore, we shall not burden the reader with further details on this subject.

UNITED ENGINEERING TYPE OF LINE

Figure 3 illustrates a tinning line of the type developed by the United Engineering and Foundry Company in cooperation with the Hanson-Van Winkle-Munning Company. The present rated speed of new lines of this type is 600 fpm, but it is said that possibly this speed may be increased to 1000 fpm later on. This line also is provided with two cone-type uncoilers. In this case, each cone is connected to a drag generator as shown. Next in the line is a four-high pinch roll with integral shear, followed by the seam welder, the entry pinch roll, and a 40 ft deep looping pit for loop storage while welding coils together. Then the strip passes through the No. 1 drag unit, which maintains back tension on the entire center section of the line, through a short electrolytic cleaning process, a scrubber, acid etch, another scrubber and into the plating unit which consists of 24 sections. The bottom side of the strip is plated in the first 12 sections, then the strip doubles back over itself and the other side (now on the bottom) is plated in the other 12 sections. Next comes the solution reclaim, a cold rinse, a long drip pan, a metallic brush burnishing unit, a hot rinse, a hot air dryer, and the main puller bridle rolls. A slight operational loop is maintained between the main puller and the No. 2 drag unit for purposes of strip guiding. The No. 2 drag unit holds back tension on the strip as it passes through a branner (if used), a pusher pinch roll which engages and pulls the strip while changing reels, and a selector shear, to either of the two winding reels. The winding reels are equipped with belt wrappers and it is said that the equipment is suitable for changing from the full reel to the empty reel at high speed. A magnetic pickup which recognizes the approach of the lap weld, initiates starting of the pusher pinch roll and the empty reel, as well as operation of the selector shear and belt wrapper.

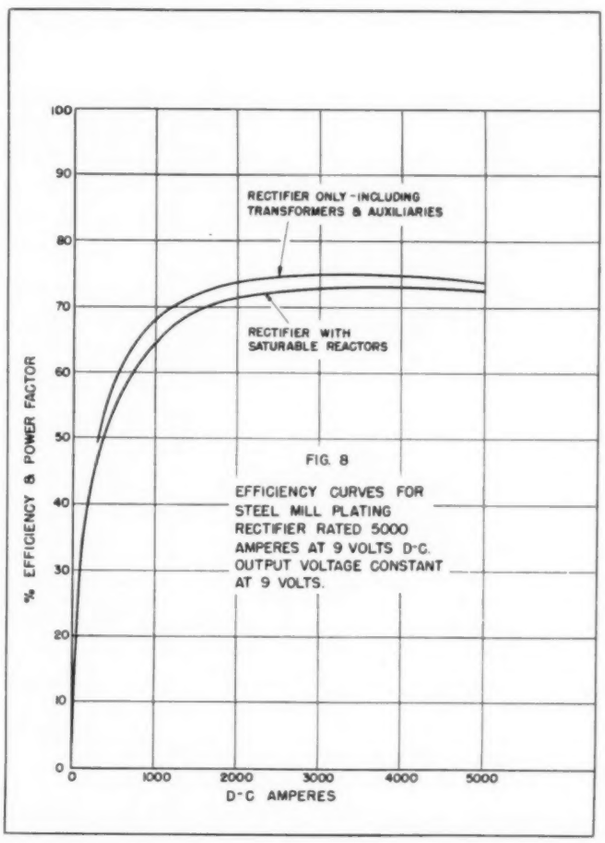
The manufacturer of this equipment also has designed a similar line with a flying shear and classifier on the delivery end of the line instead of the winding reels as shown. If the shear is used, we would recommend motor circuits similar to those shown in Figure 2.

Adjustable voltage d-c drives are recommended for this type of line for the same reasons previously mentioned on the other two lines.

The circuit for the entry end section of the line differs from those previously discussed only in that two drag generators are employed on each uncoiler instead of one. The use of two machines on each uncoiler has some advantages, however, whether they are important enough to justify the extra cost, is debatable.

The plating section and delivery end of the line should both operate from one adjustable voltage generator as shown, because accurate speed matching is required throughout this section. Except for the small loop for guiding ahead of the No. 2 drag unit, the strip is held under controlled tension through this part of the line. Automatic current regulators control tension ahead of the main puller and also at the winding reel. The pusher pinch roll and the two reels must be equipped with resistor starters to permit stopping and starting of these units while the line is running. Dynamic braking is needed on the reels to assist in stopping the full coil.

Figure 8 — Efficiency curves for rectifier unit especially developed for continuous tinplating lines.



A-C AUXILIARY MOTORS

All of the lines discussed above require a number of a-c motors in addition to the d-c motors so far mentioned. These motors are for solution pumps, acid pumps, hydraulic system pumps, scrubbers, brush burnishing, auxiliary pinch rolls, upcut shears, welders, looper hoists, bran handling, blowers, fans, motor-generator set drives and many others. For these applications, standard squirrel cage motors are usually adequate, nearly always with standard speed-torque requirements. For driving the motor-generator sets, and

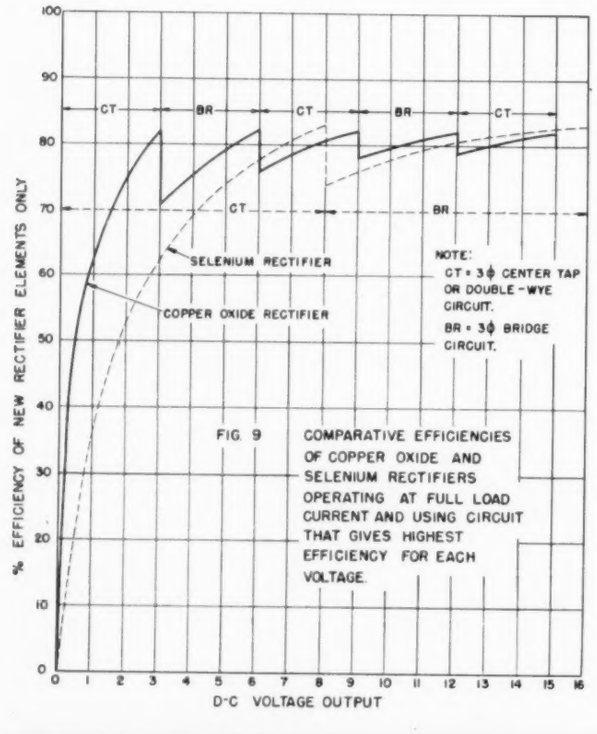
perhaps a few of the other applications where the motors will be located in a clean dry place, standard open type motors are entirely satisfactory. Most of the other motors, however, should be of the totally enclosed construction.

CONVERSION EQUIPMENT

One of the most important considerations in selecting electric equipment for a continuous plating line is the type of conversion equipment to be used to supply the low voltage direct-current needed for the actual electroplating process. The d-c plating current required for one of these continuous lines averages about 60,000 amperes. The voltage required is usually between 6 and 12 volts. Until recently, for installations of this size and nature, there was no alternative to the installation of conventional rotating apparatus for this purpose. However, for a long time many users have expressed dissatisfaction with their conventional high current, low voltage d-c generators, principally because of the high maintenance cost. (Reliable figures indicate at least 6 per cent of motor-generator set first cost per year for maintenance, not counting depreciation).

Copper oxide rectifiers — Realizing the need for better low voltage, high current conversion equipment, the writer's company has pioneered in the development of large size, heavy duty copper-oxide rectifier units, designed especially to meet steel mill requirements.

Figure 9 — Curves showing comparative efficiencies of copper oxide and selenium rectifiers.


% EFFICIENCY OF NEW RECTIFIER ELEMENTS ONLY
D-C VOLTAGE OUTPUT
CT
BR
SELENIUM RECTIFIER
COPPER OXIDE RECTIFIER
NOTE:
CT = 3φ CENTER TAP OR DOUBLE-WYE CIRCUIT.
BR = 3φ BRIDGE CIRCUIT.
FIG. 9
COMPARATIVE EFFICIENCIES OF COPPER OXIDE AND SELENIUM RECTIFIERS OPERATING AT FULL LOAD CURRENT AND USING CIRCUIT THAT GIVES HIGHEST EFFICIENCY FOR EACH VOLTAGE.

The response of the operating companies to this new development has been extremely gratifying. We are now manufacturing these large copper-oxide rectifier units to equip three continuous electrolytic plating lines, each line requiring 60,000 amperes at 9 volts d-c.

The use of dry type rectifiers in the electroplating field is not an innovation. In Europe, they have been used with apparent success for many years, and in this country we have been quite successful with smaller units (up to 500 amperes) of which there are single installations as large as 30,000 amperes. Our experience with these smaller units has convinced us that units as large as 5000 amperes at 9 volts are entirely practical.

Figure 4 is a photograph of one of these units, showing the external appearance of the unit. Twelve of these units will be installed on one continuous strip plating line. Figure 5 shows the general arrangement of the 5000 ampere, 9 volt unit. This illustration indicates how the large unit is electrically made up of four smaller units, each with its individual transformers and rectifier stacks. It will, therefore, be readily seen that the unit inherently possesses great flexibility in the way of parallel, series parallel, or series connection of the four sets of outgoing d-c buses. This figure also illustrates how the completely self-contained, ventilating and cooling system is built in to the rectifier unit. One of the basic considerations involved in selecting this type of design, was the fact that the tinning line itself always requires a fairly large quantity of clean water for rinsing and washing purposes. This water can just as well be used for cooling water before it is used for rinsing. In other words, essentially free cooling water is available for this purpose. This feature, with recirculating ventilation provides a unit which is complete in itself, does not require auxiliary ventilation or cooling and can be mounted in almost any location.

Some of the problems which were encountered in connection with the application of rectifiers to continuous strip plating lines have been very interesting, for instance:

From a performance standpoint, the rectifier must compete with the flexibility and smoothness of load control provided by field control of the high current d-c generator. The necessary performance in this respect was obtained by using saturable core reactors in the primary power circuit to the rectifier units. Figure 6 shows the fundamentals of the power circuit used. With approximately a constant resistance load, saturable reactors can readily be furnished which will give a 10 to 1 range of output voltage, and larger ranges can be obtained if needed.

Figure 6 also illustrates two basic transformer circuits which can be used. The circuit selected will depend entirely upon what maximum d-c voltage is required. Copper-oxide rectifiers are inherently good for about 6 volts per plate in the blocking direction. The bridge circuit shown on the left in Figure 6 provides a rectifier rated 6 volts d-c with one rectifier plate in each leg of the 3-phase bridge. Using the same transformer circuit with rectifier plates in series, ratings in multiples of 6 volts can be obtained. Thus, we use this circuit for rectifiers with d-c output voltages of 6, 12, 18 volts, etc. However, if we use this same circuit to obtain a rectifier with a 9 volt d-c output, we must use two plates in series, that is, we actually get a 12 volt rectifier as far

as the plates are concerned. This is more expensive and less efficient than a rectifier which uses each plate up to its full rating. Therefore, for rectifiers rated at 3 volts, 9 volts, and 15 volts, we use a double-wye transformer secondary connection as shown on the right in Figure 6. With this connection we can use each rectifier plate to its full rating and obtain the same efficiency at any voltage which is a multiple of three. This transformer connection is well known, but has been little used with dry type rectifiers.

Comparative efficiencies — Comparative overall efficiencies of motor-generator sets and rectifiers, is one of the things which must be carefully considered when choosing between them. Figure 7 gives a few overall efficiency curves which make an interesting basis of comparison. It will be noted that these curves are plotted on the basis of a constant resistance load on the d-c circuit. This was done to approximate as closely as possible the actual operating condition on a continuous tinning line, where the load is changed by changing the d-c voltage, while the resistance of the plating bath remains approximately constant. It will be seen from these curves that there is not much difference in full load efficiencies between large motor-generator sets and large rectifier units, but that the rectifier has a decided advantage at light load. A motor-generator set with larger generators will have better efficiencies than those shown, but for 9 volts output the efficiency will tend to be lower, therefore, the curves shown would seem to be a fair comparison.

In comparing the full load efficiencies of motor-generator sets and copper-oxide rectifiers, it will usually be found that the rectifier has a definite advantage at 6 volts, they are about equal as 9 volts, and the motor-

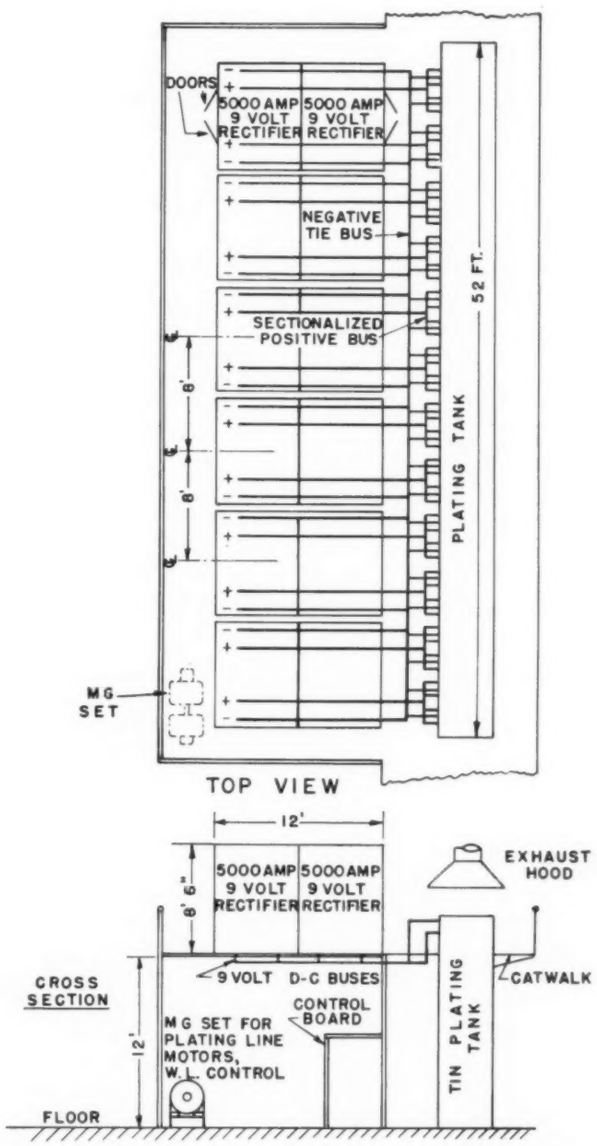
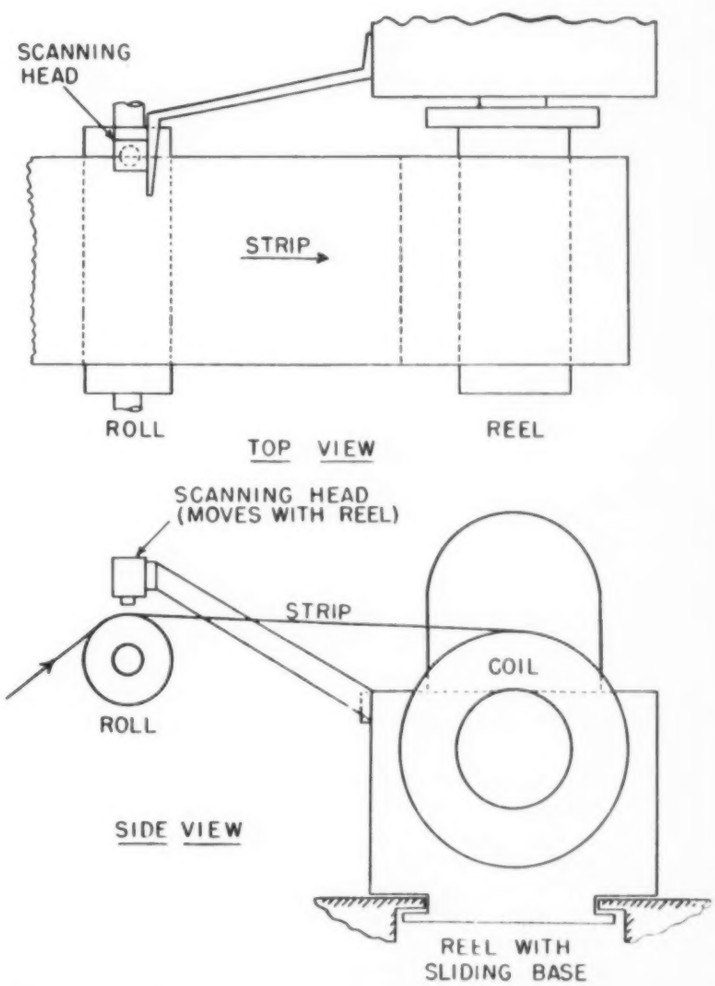


Figure 10 — Plan view and cross-section of plating tank of tinning line with rectifier installation.

Figure 11 — Sketch illustrating automatic photo-electric control of "floating reel."



generator set has a slight advantage at 12 volts. Above 12 volts, the advantage of the motor generator set tends to increase.

Figure 8 shows efficiency curves on a 5000 ampere-9 volt rectifier unit, of the design developed especially for continuous tinplating lines. These curves were plotted from actual test data, and give efficiencies at full voltage, of the rectifier alone, and also of the combination of the rectifier and the saturable reactor in the primary circuit.

Copper oxide vs. selenium rectifiers — During the past year, there has been much discussion concerning the relative merits of copper-oxide rectifiers versus selenium rectifiers. This is still a somewhat controversial subject which will not be finally settled one way or another until we have had many years of actual operating experience with large units of both types. Several equipments are now on order for large selenium units for tinning line installations. It will be interesting to watch the performance of these units in comparison with the copper-oxide units which are also being installed this year. At least one installation will have a direct comparison of the two types of rectifiers. A 5000 ampere, 9 volt, oil-immersed selenium unit is being installed on the same tinning line with eleven 5000 ampere, 9 volt copper-oxide units. These units, of course, will get identical service, and should form an interesting basis of comparison. So far, the more conservative electrical manufacturers in this country have not manufactured or sold any of the selenium type rectifiers for large electroplating applications. The reasons for this are that the characteristics of the two types of units when used for this service are not enough different to warrant any drastic change from a unit which we know and have confidence in, based on years of experience, to a unit which is relatively untried. The selenium units have a definite field of application, but whether that field should be extended to include heavy electroplating units remains to be seen. Space does not permit a more thorough discussion of this subject, but I would like to correct a common misconception. Somehow, the idea that selenium rectifiers are inherently much more efficient than copper-oxide units has become quite widespread. Figure 9 will provide an interesting comparison of the actual efficiencies of the two types of elements.

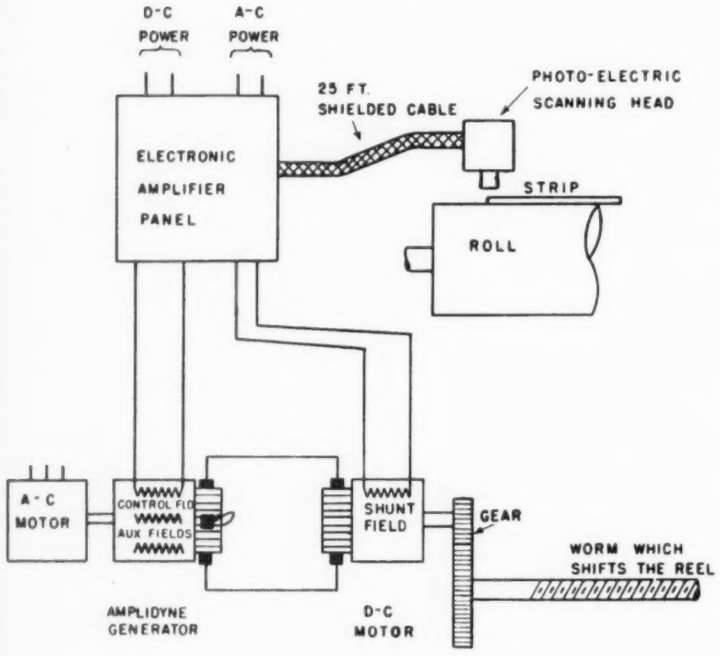


Figure 12 — Diagram showing the use of an amplidyne generator in automatic reel shifting control.

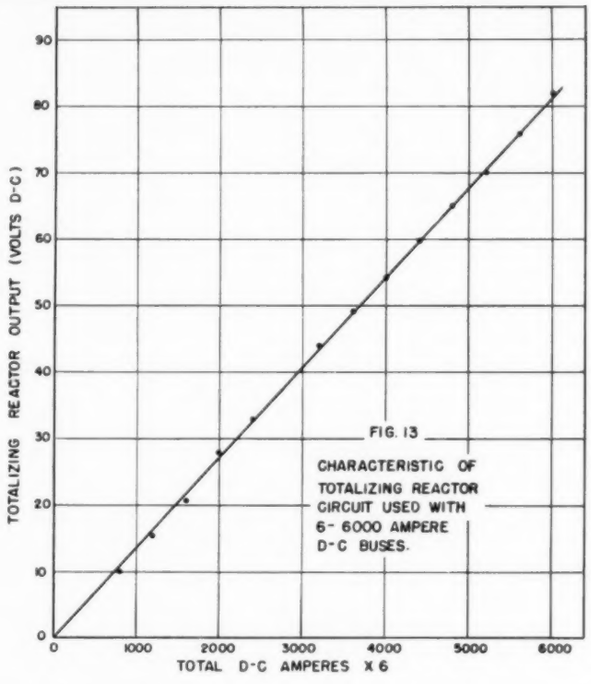


Figure 13 — The relationship between the summation of currents and d-c output voltage is a straight line.

Advantages of dry type rectifiers — On several installations now being made, it has been found that definite economies in floor space can be realized, and some shortening of the heavy copper buses can be effected by taking advantage of the fact that the rectifiers can be mounted on a balcony or other structure right along side of the plating tank proper. Motor-generator sets are usually located in a basement or ground floor motor room which sometimes results in a longer run of high current buses. Figure 10, showing a plan view and a cross section of the plating tank of a continuous tinning line with rectifier installation, illustrates several of the advantages of rectifiers over low voltage motor-generator sets. The advantages are outlined as follows:

1. Saving in maintenance.
2. Saving in total floor space required.

3. Saving in installation cost:
   a. Possibility of shorter high current buses.
   b. No special foundations required.
   c. Ventilating and cooling equipment is built in as a part of the apparatus.
4. Greater flexibility:
   a. Smaller units, therefore, less loss if one is down.
   b. More readily reconnected in series-parallel circuits for changes in voltage and current requirements.

For a 9 volt installation, the cost of rectifiers as described is approximately the same as the cost of motor-generator sets plus their cooling and ventilating equipment. At 6 volts, the rectifier installation has a

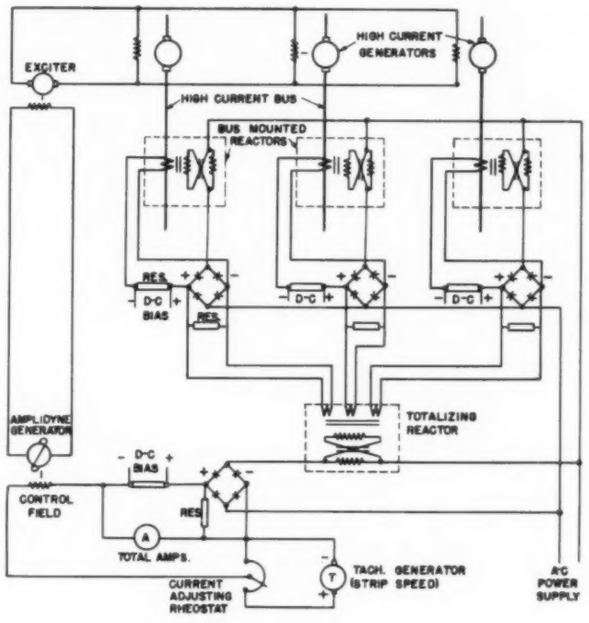


Figure 14 — Simplified schematic diagram illustrating method of synthetically totalizing currents to plating tanks.

definite advantage in first cost, and at 12 volts, the advantage is in favor of motor-generator sets. However, even at 12 volts, the 5 per cent annual saving in maintenance which we expect to show should easily justify the extra first cost for rectifiers.

AUTOMATIC "FLOATING REEL" CONTROL

As was previously mentioned in discussing the Crown Cork and Seal type of tinning line, one very interesting feature on this line is the use of the so-called "floating reel" to insure the winding of coils with square ends. The conventional strip processing line has a loop just ahead of the back tension device for the purpose of guiding the strip at this point. The "floating reel" principle, however, does not guide the strip at all, but automatically shifts the reel back and forth laterally to compensate for the lateral variations in the position of the strip as it comes from the back tension unit. In other words, instead of the strip being guided to correspond to a stationary position of the coil, the coil is guided to correspond to the variable lateral position of the strip. This method of operation has one big advantage; by its use, it is often possible to completely eliminate one drive which would otherwise be necessary in the line for the sole purpose of providing a loop for guiding. The mechanics of this system are simple. The reel, including motor and gearing, is mounted on a sliding base which is moved laterally by a worm gear which is driven by motor. On some installations, mechanical limit switches are being used to indicate the lateral location of the edge of the strip as it comes from the back tension unit. These limit switches provide the signal for the operation of a reversing a-c motor which drives the worm. A slight refinement of this system is the use of two continuously running a-c motors, each equipped with a magnetic clutch, one for shifting the reel in each direction. However, we were not entirely satisfied with either of these schemes, and based on considerable experience in the guiding of paper under somewhat similar conditions, we have developed a photoelectric-amplidyne circuit for this application. Figure 11 illustrates the mechanics which are involved in this application. The photoelectric scanning head is focused on the edge of the strip as the strip passes over a dark colored roll. This roll may either be a part of the back tension device or an idler roll. Whenever the edge of the strip gets very slightly off center beneath the lens of the scanning head (about $\frac{1}{32}$ in. or less), an electrical impulse is initiated which results in a shifting of the reel to the correct position to keep the coil square. Since the scanning head is mechanically mounted on the reel structure, it also moves in the same direction. As soon as the edge of the strip is exactly centered under the scanning head lens again, there is no signal to move, and the reel stops sliding.

Figure 12 indicates very briefly the fundamentals of the electric circuit which we are providing to perform this function. The signal from the photoelectric scanning head is amplified in a small electronic amplifier panel which feeds this amplified signal into the control field of an amplidyne generator. The amplidyne generator is electrically direct connected to a d-c motor which drives the worm which shifts the reel. The high amplification factor and the high speed of response of the amplidyne generator makes this simple circuit practical. This circuit gives fast, accurate response without any contactors or clutches in the electrical circuit. No magnetic brake is necessary on the d-c motor, since fast regenerative braking is automatically provided. Another advantage is that the speed of the shifting motor is automatically proportional to the strength of the signal, which in turn is proportional to the amount of correction needed.

SYNTHETIC CURRENT TOTALIZING

On most tinning line installations, the operators prefer to be able to read the total plating current on the line on one instrument. Sometimes there is also a recording ammeter for this purpose. The conventional

way of doing this would be to run one bus from each high current generator or rectifier through a common instrument shunt. However, an instrument shunt which will carry 60,000 amperes continuously is a very large and expensive piece of equipment. Also, if the d-c conversion equipment is distributed along the plating line, as is often the case, it requires considerable additional copper bus-work in order to run all high current circuits through one shunt. The shortage of copper in these times practically prohibits its use for this purpose, and in addition, there would be appreciable power loss in the additional copper buses and large shunt. We have, therefore, devised a method of synthetic totalizing of the d-c current in a number of high current circuits without actually bringing the circuits together. Using the saturable reactor principal, with certain modifications and refinements, we have developed a circuit which gives a d-c output voltage which is directly proportional to the summation of a number of d-c currents. Figure 13 shows the straight line relationship between summation of currents and the d-c output voltage. In order to read total amperes, it is merely necessary to have a voltmeter which has its scale calibrated in amperes.

AUTOMATIC CURRENT-SPEED REGULATION

Another problem which is closely related to synthetic current totalizing, is that of automatically holding the total plating current proportional to strip speed. Some operators claim that in order to plate a constant weight of coating, the direct proportionality of speed and plating current does not hold over wide ranges. Others say that it does, and I do not wish to take sides in this controversy. However, if by more accurate control of plating current at any given strip speed, we can produce a more uniform thickness of coat and thus save even one per cent of the tin used on one of these lines, it would amount to about 10,000 lb of tin per year.

Figure 14 is a simplified schematic diagram, showing the essential components of the circuit which we are using for synthetic current totalizing, and an automatic speed-current regulator of the amplidyne type. On each high current bus, there is a bus-mounted saturable reactor, for which the bus itself furnishes the saturating d-c winding. In fact, the bus furnishes too much saturation current for a small reactor, and in order to keep the size of the unit down, a feed-back circuit is employed which obtains its power from the output side of the rectifier and neutralizes part of the ampere turns provided by the d-c bus. The output of the a-c circuit on this reactor is rectified and the d-c output from this rectifier is fed into one of several coils on a small totalizing reactor. The a-c output from this totalizing reactor is rectified, and by providing a suitable d-c bias to take care of the magnetizing current, it is possible to use this output directly for metering purposes. If a speed-current regulator is to be used, it is merely necessary to buck this d-c output voltage against a portion of the output voltage of a tachometer generator (which gives a voltage proportional to strip speed), and feed the differential between these values into the control field of an amplidyne generator. The amplidyne generator operates on the field of the exciter which supplies potential to the fields of the high-current generators, or to the d-c coils of the saturable reactors in case rectifiers are used. This type of regulator is fast, accurate, simple and flexible.

ACCESSORY EQUIPMENTS

There are several types of accessory equipments which some operators are installing to operate in tandem with the tinning line proper, and which have not yet been mentioned. For instance, several installations are being made with a side trimmer operating as an integral part of the equipment at the entry end of the line. This equipment is of conventional design, and its inclusion in the line presents no great problem as far as the electric equipment is concerned.

Another very important accessory which is either being added or seriously considered for the most of the lines is some type of electric flow brightening equipment. Originally, there was division of opinion as to whether any type of flow brightening was necessary, but it now seems to be fairly well agreed that some type of thermal flow brightening, either in the line or as a separate process, will be necessary. There are two basic methods of doing this job electrically, (1) by high frequency induction, and (2) resistance heating by passing a high current through a section of the strip itself at power frequency. This subject of flow brightening is deserving of a more detailed discussion than space permits at this time.

Both of the suggested methods are being incorporated into production equipment on full sized lines, and the operating experience which will thus be obtained on both types of equipment will eventually show which type is superior. Where flow brightening equipment is installed in a plating line, it will necessarily be located in the constant speed section of the line, and usually just ahead of the branner if one is used. This location of the equipment will present no unusual problems as far as the electric drives are concerned.

CONSERVATION OF CRITICAL MATERIALS

In these times of shortage of critical materials we should all do as much as possible to conserve materials wherever we can do so without sacrificing performance. A few of the ways to get more horsepower per pound of electric equipment are:

1. Use higher speed motors and motor-generator sets.
2. Use standard open type machines.
3. Use the 15 per cent service factor on 40 degree machines.
4. Use standard open type d-c control panels.
5. Use standard full voltage a-c starters without special enclosures.

These are only a few examples of what we may be forced to do unless we all voluntarily do as much as is possible, consistent with reasonably sound engineering practice. Recently, I saw a list of suggestions originating from the WPB of which the above is a very small and innocuous sample. Therefore, it behooves us all to do as much as we can, before we are told what we can

and cannot do by those who may not fully appreciate our application problems. We should all consider it our patriotic duty to cooperate in this respect. Purchasers of electric equipment can also save valuable time for themselves and precious man-hours for the electrical manufacturer, if they will specify standard types of equipment whenever possible.

DISCUSSION

PRESENTED BY

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G. E. STOLTZ, Manager, Metal Working Engineering, Industry Engineering Department, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania

J. H. HOPPER, Industrial Engineering Department, General Electric Company, Schenectady, New York.

R. A. GEUDER: I would like first to endorse everything that Mr. Hopper has said in regard to the conservation of material, and the remarks at the end of his paper should be taken seriously.

With Mr. Hopper's permission, I would like to suggest several corrections in his discussion of the Carnegie-Illinois tinning line. He was correct in his sketches and discussion as of the time of the negotiations, but certain things have happened since then to change it somewhat. There are not as many classifier units as originally shown on the diagram, as it was quite considerably simplified.

There was one thing, however, that came up that I think is important purely from an operating standpoint, and that is in the discussion of a grouping of motors on pilers, flying shears and branners. The sketch a shown in the paper would suggest a grouping of the flying shear with the main drive bridle on one generator, and putting the branner, lapping pinch roll, conveyors and pilers on still another generator, simply because the piler and branner combination might run at a speed different from line speed. I think we are all aware of the fact that the piler conveyors must be in synchronism with the flying shear which produces the sheets that we are going to pile if we wish to maintain good lapping for good piling. Therefore, the flying shear, lapping pinch rolls and piler conveyor should be on one generator.

We further believe it is wise to divorce the center section of the line from any other disturbing influence, and would, therefore, suggest that the drawing be made to show it as it exists with the main drive bridle on its own generator; therefore, relieved of any disturbances from flying shears and other synchronizing units.

Incidentally, it might be interesting to note that very little extra load is put on the plant's d-c supply because the entire line, being on variable voltage, gets its power supply through the motor-generator sets.

I should like to add some comments on selenium rectifiers. There is no question but that selenium rectifiers are new in the United States. They are old in Europe. There is a record of a number of installations, some going back as far as fifteen years in Europe in successful operation. Also, we have records which have just recently been supplied from England on a 20,000 ampere plating unit which has been in service for four years on a continuous 24-hour basis with no change in efficiency.

The selenium rectifier offers certain advantages. It can be oil immersed and does not, therefore, need to be put in air-tight filtered air construction. This oil immersion is highly desirable to keep out fumes and all the injurious atmosphere that certainly would not do any good to any type of dry rectifier. The selenium rectifier does not need to operate within a close temperature range. In fact, the allowable operating temperature rise closely approaches that for rotating equipment.

Efficiency curves of copper oxide versus selenium, as Mr. Hopper presented them, indicate that, depending on where you happen to be on the scale, you can prove either one of them to be the better. It is a fact, however, that certain low-voltage equipment suppliers do have a tendency toward considering selenium very seriously, and perhaps it is for operating characteristics other than efficiency. I am not aware of all the reasons.

The totalizing reactor scheme that Mr. Hopper mentioned is a very clever one. We had a similar problem presented and handled it in a little different way. I will try briefly to describe it. Instead of totalizing reactors, we used a regulator with several coils, each coil of which received an MV drop from its respective circuit. Those coils were imposed upon a rather simple magnetic circuit which was also influenced by a tachometer generator coil so that we had a relationship of total currents to line speed. Any variation in the tachometer bias would give a variation in current and at all times current versus speed was proportional.

The author also mentioned reflow units, and I think it is correct to say that all of the electrolytic tinning lines that are being installed now, at least all with which I am familiar, will have some type of reflow unit. By way of interest, those that are being built along the lines developed by the Crown Cork and Seal Company, which was Figure No. 1, frequently have reflow units as separate lines. They usually require two reflow lines per electrolytic line. The reflow line itself is almost identical in operation with the electrolytic line, with the exception of speed and the fact that there is a vertical heat muffle instead of a horizontal electrolytic tank. However, the individual elements are the same — entry pinch roll, entry loop, main pinch roll, delivery loop, drag unit and recoiler, variable-voltage generator sets, etc. — all quite the same as Figure No. 1.

G. E. STOLTZ: The installation of these electrolytic lines has brought to the forefront the use of rectifier units. Previous to this time, the installations were made with high current low voltage generators, which apparently have been very satisfactory. Recently rectifier units have been changed in design from that previously used where a large amount of external air was required.

To make such a unit practical for these applications where there is as much as 60,000 amperes required, some different method of handling the air was necessary. Such an installation would require as much as 175,000 cubic feet per line. Mr. Hopper has explained how this has been avoided by placing a heat exchanger in the cubicle, and recirculating the air within the cubicle. We have gone one step further; that is, we have included the saturable core reactor to regulate the voltage. We have also included in the cubicle a disconnecting contactor, so that each cubicle is complete in itself, and if an operator cares to work on it, the cubicle can be removed from the line by merely tripping this breaker.

In regard to regulation, the method of proportioning the electrolytic current to the speed of the line where generators are used is to work on the fields of the generators. With rectifier units, this is accomplished by adjusting the d-c voltage imposed on the saturable core reactors.

The scheme that we use for totalizing the electrolytic current is a rather simple one in that we use rotating regulators. The fields of these rotating regulators are excited from shunts in the rectifier load circuits and a summation of the regulator armatures made by connecting them in series.

One other factor in Mr. Hopper's paper that may be mentioned is the importance of maintaining synchronism of the individual motors on these lines, particularly those lines that are slowed down in speed at times when the coils are welded end to end. This often brings the motors that operate these individual units down to a voltage comparable to the drop in their own armature, so we have been including on these individual direct current motors a compensating winding that will give a very flat speed regulating curve as well as IR drop compensation. This gives the same synchronization at the lower speeds as at the top.

J. H. HOPPER: For the purpose of this paper, we believe it is not important whether there are four motors or eight motors on the classifier. The only point I wish to make is that these small motors can be successfully grouped on a single controller and with a common IR drop booster.

With regard to the grouping of the various motors on the adjustable voltage generators, the circuits shown are what we would recommend and are not necessarily duplicates in every detail of the circuit being furnished for any particular installation. I did not intend to convey the impression that it is unnecessary to maintain a certain degree of speed relationship between the shear and the classifier. Certainly, the branner and most of the conveyor belts must always run somewhat faster than the shear to prevent overlapping of the sheets, and the piler belt must run somewhat slower than the shear to assure proper lapping of the sheets. However, if these speed relationships are properly selected, a small variation in the relative speeds of the leveler shear and the classifier can be tolerated. But no appreciable variation in the relative speeds of the main puller and the leveler shear can be tolerated, because these drives are tied together with the strip, and we do not even have strip tension between them to help maintain synchronism. The loop between these two drives is too short to provide any appreciable storage of strip. Therefore, we believe that placing the main puller and the leveler shear on separate generators is unnecessarily handicapping the operation of the line. The difficulty of controlling the loop during acceleration and deceleration would probably result in having to bring the line speed up or down rather slowly. We know of at least one instance where serious trouble was experienced because separate generators were used on either side of a short operational loop in a processing line.

With regard to the disturbing influence of the shear if on the same generator with the main puller motor, the current swings on the shear motor would only be a small fraction of the generator capacity and would cause no difficulty if the proper generator design is employed. Also the type of speed-current regulator which is described in this paper would help assure stable operation.

With regard to copper oxide rectifiers, I wish to correct Mr. Geuder on one minor point. The copper oxide rectifiers described are not provided with air-tight enclosures, nor is any filtered air employed as the cooling medium. The enclosures are about the same as ordinary control or switchgear cubicles as far as tightness is concerned. The copper oxide rectifier is inherently not so vulnerable to atmospheric fumes as is the selenium unit because the actual rectifying surface is protected by a coating of copper oxide, a heavy coating of nickel plate, and the whole unit covered with a high grade baked-on varnish; whereas in the selenium unit the rectifying surface is normally covered only by a thin layer of a very soft low melting point metal.

Regarding the statement about reflow units for the Crown Cork and Seal type of line, most of these lines are now being installed with electric reflow units built right into the tinning lines.

In our rectifier design, we purposely did not include the saturable reactor as an integral part of the rectifier unit. The unit is already rather large, and the addition of several thousand pounds of reactors would complicate the handling and installation problem, in addition to making other parts less accessible. Also better flexibility of application is obtained, since with our design it is possible to group several rectifiers on one set of reactors, or to use some other form of primary voltage control such as induction regulators or tapped transformers without modifying the design of the basic rectifier unit.

Some of the drives on these lines require close synchronization, or speed matching with other drives, while others do not. For example, the type of line shown in Figure 1 happens to be constructed so that no particular attention need be given to accurate speed matching of the various drives. The current regulators on the entry and delivery ends of the line maintain essentially constant tension on the strip at these points, and, of course, speed matching for these sections of the line is a by-product of tension regulation. The center section of the line has only one drive, and the storage loopers on either side of this section take care of any momentary difference in speed between this section and the two ends. There are cases, of course, where accurate speed matching is necessary, and for these applications the methods suggested by Mr. Stoltz are fine. However, particularly in these times, we should not put on extras such as IR drop compensation and special flat speed-load motors except where they are actually needed.

Electric Fusion of Tinplate-

. . . . induction heating for reflowing tin, although higher in first cost, offers a speedy, stable process, with compact heating medium requiring no contact with the strip . . . .

by G. E. STOLTZ, J. A. HUTCHESON *and* R. M. BAKER

Westinghouse Electric & Manufacturing Co.

EAST PITTSBURGH, PENNSYLVANIA

▲ TIN deposited on steel strip electrically is porous and of a crude matte structure. It is refined by heating it to its fusion temperature which also gives it a smooth bright surface. In this form it has improved corrosion resisting properties.

In the first stages of this development, this process was accomplished by heating the tinplate in an oil bath or in a gas fired radiant tube furnace. In each case the temperature of the body supplying the heat is materially above the fusion temperature of tin. The strip is passed through the brightening furnace at a constant speed selected to permit it to obtain a temperature slightly above the fusion point of the tin just before it leaves the furnace.

While the oil and radiant tube furnaces have much to recommend them for early pioneer installations, they do have certain limitations for large high speed lines. This is true where the fusion equipment is to be installed immediately after the electrolytic process, and where it is desired to vary the speed of the strip over a wide range between the normal travel and the slower speed used while one coil end is being welded to another.

Two electrical methods, one termed conduction and the other induction may be used as in either case the power input can be quickly and accurately adjusted as the thickness or the speed of the strip is changed.

The conduction method employs metallic rolls over which the strip passes. Current is introduced to the strip from these metallic rolls to a value required to heat the tin just above the fusion temperature before the strip enters the quench tank.

Power from a commercial frequency circuit can be used either three phase or single phase. Various methods have been used one of which is shown diagrammatically in Figure 1. In this instance single phase power is used having one terminal of the heating transformer connected to a top roll and the other terminal of the transformer connected to the two bottom rolls. With this arrangement it is possible to ground a bus to which the two bottom rolls are connected so that ground potential is obtained on the metal as it enters and leaves the flowing equipment.

Copper rolls are usually used having current collecting rings on the shaft next to the roll. In order to assure good contact between the strip and the conducting rolls, it is customary to install one or more pinch rolls which bear against the opposite side of the strip.

The power input to the heating transformer can be varied by several methods, one being an induction regulator, another a saturable core reactor, and a third by means of grid controlled tubes.

The distance between the entry conductor roll and the quench roll is in the order of 40 to 50 feet depending upon the manner in which the power applied to the strip is proportioned between voltage and current.

The overall efficiency from the power supply should be from 70 to 90 per cent depending upon the load at which the electrical equipment is operated. The cost of the electrical heating equipment not installed for a

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line running at 500 fpm should not exceed $25,000. This does not include the cost of the conductor rolls, the supporting structure, and electrical circuits. If a non-oxidizing atmosphere is used, the cost will be materially increased.

There are three characteristics of the conduction method of heating that should receive attention. The first is the problem of passing current between the rolls and the strip without marring the tin coating, the second is that the heating continues into the quench tank, and the third is the possible non-uniform heating along the length of the strip.

Tin is a soft metal having brinnel hardness of 40 at atmospheric temperatures and 14 near its melting point as is shown in Figure 2. This means that care must be used in the mechanical handling of the strip to avoid damage to the tin surface.

A deposit of one-half pound of tin per base box results in a coating having an average thickness of .000030 in. This further stresses the importance of careful handling of a soft metal that must withstand stresses that a much heavier steel strip may easily absorb.

Aside from purely mechanical considerations, it is essential that solid contact surface be maintained between the conductor rolls and the strip to avoid arcing. An electric arc of any magnitude certainly would burn through a coating of tin .000030 in. thick, and if the surface of the conductor roll is pitted this would continue to mark the tin as long as it is kept in use. The use of pinch rolls that ride against the strip on the conductor rolls not in the quench tank will assist in obtaining good contact between the conductor rolls and the strip, and tend to avoid burning or mechanical slipping between the strip and the conductor rolls.

In general, the problem of successfully collecting current becomes greater as the speed of the line is increased and the power requirements become higher.

The second possible detriment to conduction heating is due to the fact that the heating cycle must continue into the liquid quench to the lower conductor roll.

It is necessary to flow the tin just ahead of the liquid quench, and instead of allowing it to start its cooling cycle towards solidification it is carried to a still higher temperature until it enters the cooling liquid. The power used to heat the strip after it has been fused is, of course, wasted. However, the overall consumption of power by the conduction method is less than by induction so that this cannot be considered of any great importance as far as loss of power is concerned.

The third problem of conduction heating is the possibility of non-uniform heating along the length of the strip.

In estimating the power required to heat tinplate, the effect of the tin on the strip can be neglected. A deposit of one-half pound of tin gives a total thickness of both surfaces of .000060 in. If the strip is .01 in. thick the cross section of the tin is .06 of one per cent of that of the strip. Even though the conductivity of tin is 50 per cent greater than that of the steel strip, the amount of current carried in the tin is still negligible.

If the gauge of the strip varies across the width, current of commercial frequencies will substantially distribute itself in proportion to the strip thickness and the heat generated will in general be proportional to the gauge of the strip to be heated. This is illustrated in Figure 3.

If the resistance of the left-hand heavy section is one ohm the resistance of the right-hand half section will be two ohms. If the voltage applied over the length of both sections is 100 volts, the current of the heavy section will be 100 amperes and the light section 50 amperes. The I^2R power loss will therefore be 10,000 watts in the side where the gauge is heavy and 5000 watts in the thin section of sheet. Since the left half is twice the thickness of the right and the power generated in the heavy section is twice that of the light section, the heat distribution is proportional to the gauge of the strip.

While the strip does not vary in gauge over a range of 2 to 1 the reason for non-uniform heating along the length of strip, if the gauge does vary, can be easily illustrated by assuming a section such as shown in

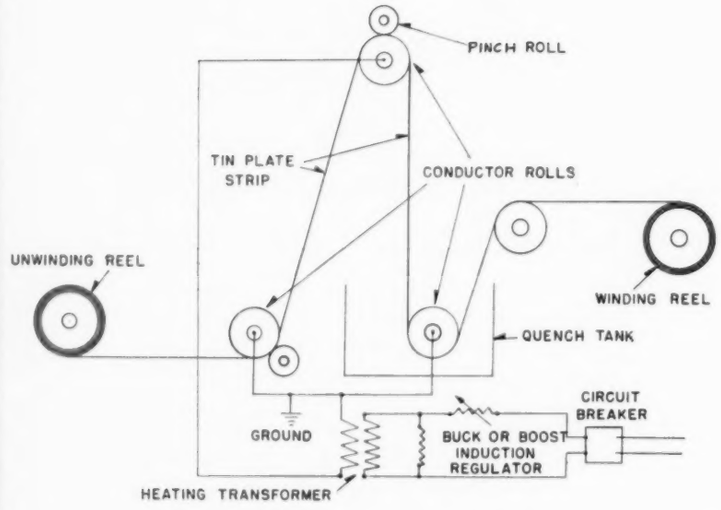
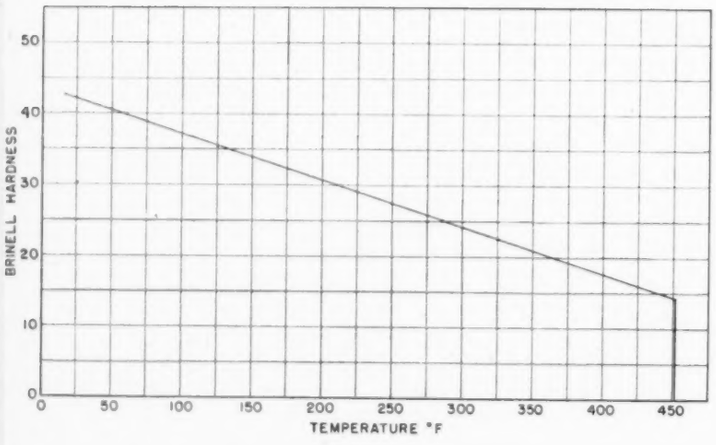


Figure 1 — Schematic diagram showing one method of heating tinplate strip by conduction.

Figure 2 — Brinell hardness of tin at varying temperature.



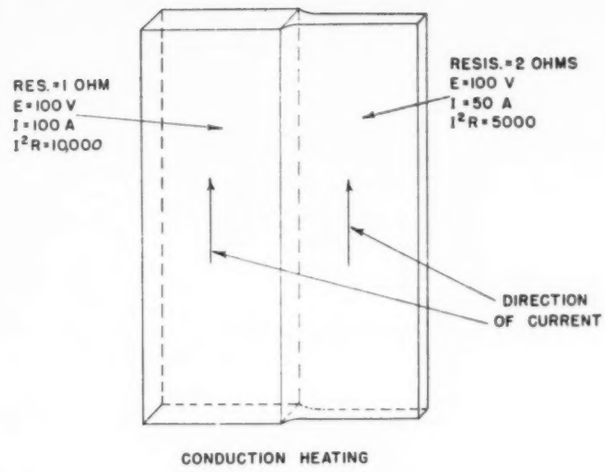


Figure 3 — Distribution of heating with variation in gauge across sheet, using conduction heating.

Figure 4 — Distribution of heating with variation in gauge along length of sheet, using conduction heating.

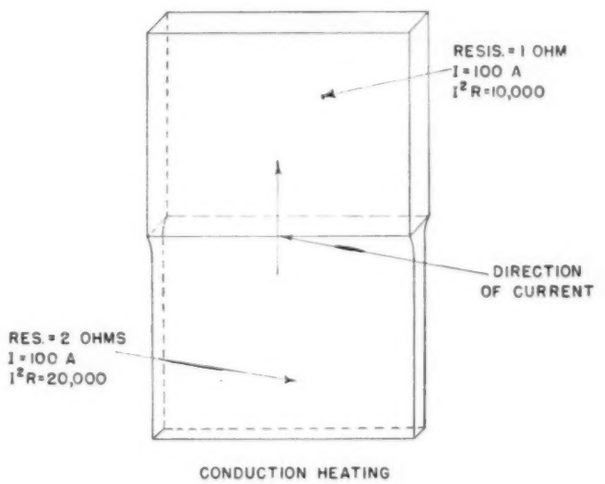


Figure 4. In this figure, the upper one-half length is twice the thickness of the lower one-half length. If the resistance of the upper heavy length is one ohm, that of the lower length will be 2 ohms. The same current will pass through both heavy and light lengths, which we are assuming to be 100 amps. The I^2R loss in the upper heavy length will be 10,000 watts while that in the lower light gauge length will be 20,000 watts. This means we are dissipating twice the heat in the light gauge length that is being generated in the heavy gauge length. Aside from greater radiation from the higher temperature sections, and a small amount of conduction from the light overheated sections to the underheated heavy sections, the ohmic resistance of the hotter light sections will increase faster than that of the heavy sections making the condition still worse and unstable.

Since the current must be high enough to flow the tin on all parts of the surface, there is danger of reaching hot spot temperatures where oxidation will occur, particularly if this process takes place in an oxidizing atmosphere.

In practice, it may be found that the variation in gauge along the length of strip does not vary enough to make this a problem of any importance, on the other hand if it is, the furnace could be enclosed and a non-oxidizing atmosphere used.

The chief disadvantage of induction heating is its first cost and efficiency. For a line having a strip speed of 500 fpm, the cost of the electrical equipment now installed is approximately $150,000 and the overall efficiency from the power line to the strip is 45 per cent. The inductor heating coil will be short so that the cost of the supporting structure should not be great. This will tend to equalize the overall first cost.

This method of heating is accomplished by passing the strip through a high frequency field of magnetic flux. There is no current collecting problem through the tin coating and the strip will not be required to make mechanical contact with metallic rolls.

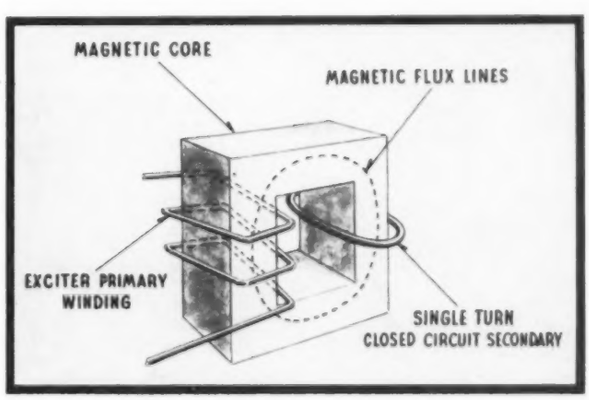
The cooling cycle starts immediately after leaving the inductor heating coil so that the tin begins to cool towards solidification before entering the liquid quench.

The principle of operation of induction heating automatically tends to correct for changes of gauge along the length of the strip.

Heating by induction permits the use of a very short furnace compared to any other method of flowing tin. The overall length of the furnace for inductor heating equipment is approximately one-foot per 100 feet travel of the strip. This makes it a simple matter to install the flowing equipment in the electrolytic line and permits the entire fusion process to be completed in a second or less, giving little opportunity for oxidation. The mechanical problem of handling the strip in short lengths is simplified and the entire process of electroplating and flowing can be completed in a minute.

To heat strip .01 in. thick by 36 in. wide at the rate of 500 fpm requires the generation of energy in the form of heat at an approximate rate of 400 kw. In a length of 5 feet the heating cycle would be completed

Figure 5 — Closed magnetic circuit with primary exciting winding and single turn closed circuit secondary.



in .6 of a second and the weight of the strip in the 5 foot length would be (.01 x 36 x 60 x .283) or 6.1 lb.

We are all familiar with the fact that greater rating can be obtained from the same weight of material in a rotating machine as the machine speed is increased. The weight of 25 cycle transformers is greater than that for 60 cycle. The weight of magnetic iron used in a 60 cycle transformer of 400 kw capacity is approximately 1250 lb, while that for the same rating on 25 cycle is 3000 lb. This is a great contrast to the 6.1 lb of steel we have available to inductively generate 400 kw in tinplate.

Three elements fix the capacity of a transformer, the first being the primary winding, the second the magnetic core, and the third the secondary winding. These

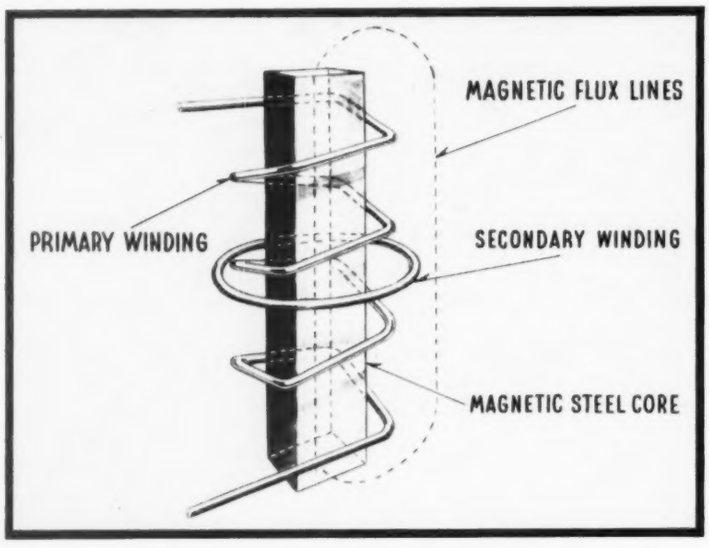
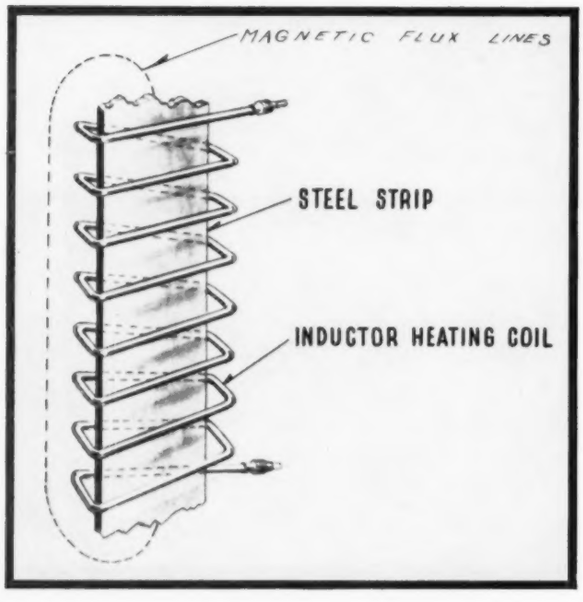


Figure 6 — Magnetic core with primary exciting winding and single turn closed circuit secondary.

Figure 7 — Typical inductor heating coil used for fusion of tin plate.



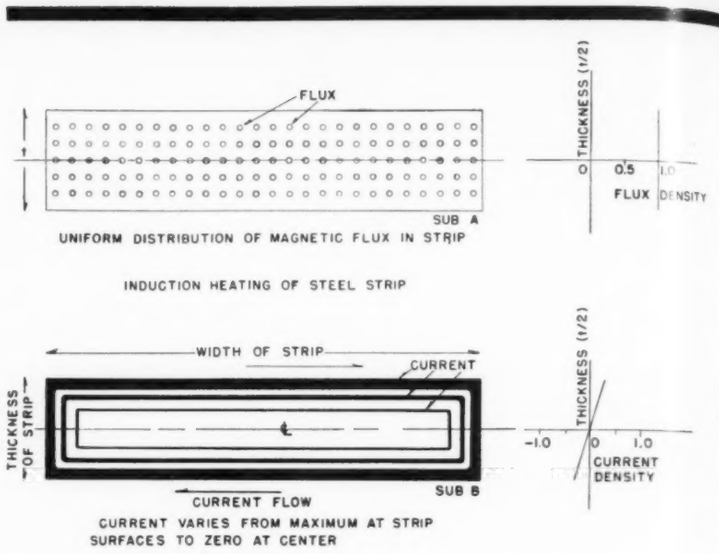


Figure 8 — Sketch showing flux and current distribution in the strip at low frequency.

three parts may be considered to be in series, each being required to handle the entire capacity of the transformer. The engineer designing a transformer is given the rating and frequency, and then selects the amount of magnetic iron and copper for the primary and secondary windings to deliver the required capacity.

Instead of having in the neighborhood of 1250 lb of magnetic material in this instance, we have but 6 lb so that the only possibility of obtaining the 400 kw rating with this amount of material is to use a high frequency, since the capacity obtained from a magnetic core is proportional to the product of the amount of magnetic flux and its frequency. In this instance this has been found to be in the neighborhood of 200,000 cycles.

Figure 5 is a diagrammatic sketch of a single phase transformer having a closed circuit magnetic core, the left leg of which has a primary exciting winding which receives its power from a suitable supply, and the secondary on the right-hand leg of the core is a closed single turn circuit. In ordinary transformer design this secondary winding would be open, having a number of turns designed to supply power to some external circuit.

The primary exciting winding sets up a reversing flux in the closed yoke, the lines of which cuts the single turn secondary. The fact that there is a reversing flux of a given magnitude and frequency in the right-hand leg of the magnetic core causes voltage to be generated in the secondary winding, and exclusive of the losses, the energy taken by the primary winding is converted into magnetic energy in the core and this again is converted back into electrical energy of the secondary winding.

Figure 6 is a similar unit except we have placed the primary exciting winding and the single turn secondary on one leg of a magnetic core; the remainder of the magnetic circuit is completed through air. This, of course, requires a very much greater exciting winding,

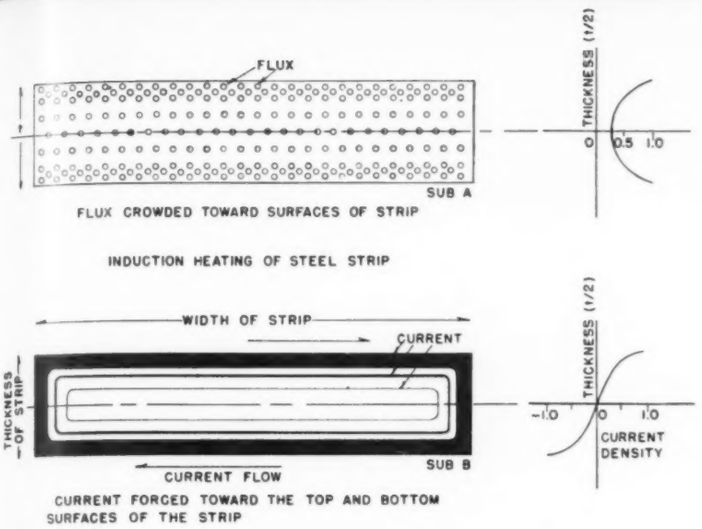


Figure 9 — Sketch showing flux and current distribution in the strip at high frequency.

but the principle of operation is the same as that for the closed circuit. This construction more nearly approaches that of heating tinplate passing through an inductor heating coil.

The exciting winding for the strip as shown in Figure 7 is usually designed to follow the contour of the strip, being wound on a rectangular form that leaves sufficient mechanical clearance between the strip traveling through the coil and its insulating core. The winding is usually hollow copper tubing with water traveling through it for cooling.

The operation of this unit is similar to that described where the open magnetic core is used, except the strip steel not only serves as a magnetic core, but also as the single turn secondary winding.

In Figure 8 we have illustrated the flux and current distribution in the strip at a low frequency. Under this condition the amount of current flowing in the tinplate would be small and the resultant flux would be established almost entirely by the primary current. The flux is uniformly distributed throughout the strip section while the current generated by this flux, varies from zero at the center of the strip to a maximum at the periphery. The cross section of the strip under the inductor heating coil forms a single turn secondary, the current increasing uniformly from the center to the periphery. In order to more easily study the distribution of the current in the strip we have assumed it is concentrated in three independent circuits as shown in B of Figure 8.

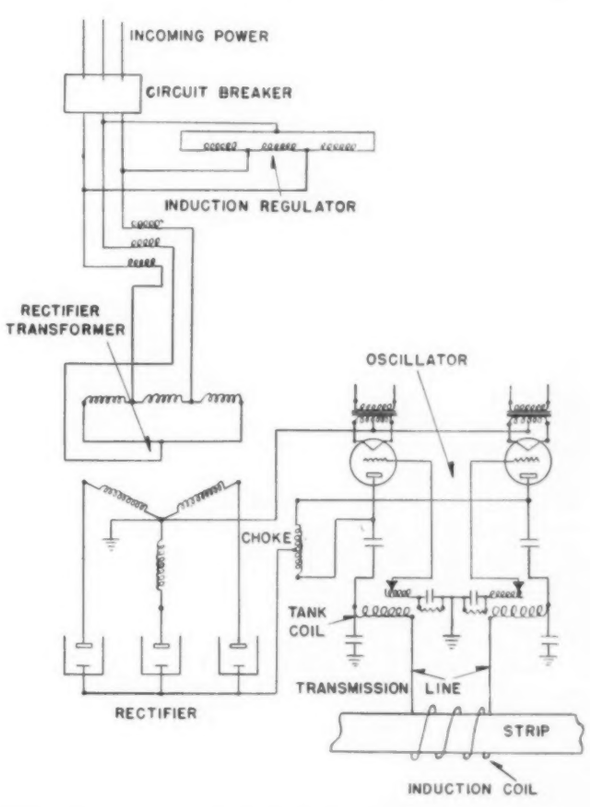
The voltage and current generated in any of these three paths will be directly proportional to the amount of flux enclosed by the path of the current. The inner current path encloses the least amount of flux and for this reason carries the smallest amount of current. The intermediate current loop encloses approximately twice as much flux so that its current should be twice that flowing in the inner current path. The outer current path encloses substantially all of the flux in the strip and for this reason carries the greatest amount of current. With uniform flux distribution in the strip the current in actual practice will vary from zero at the center to a maximum at the periphery of the strip as is shown by the curve to the right of B.

As the frequency is increased in the primary exciting coil, the amount of current flowing in the strip is increased due to the secondary current paths being cut by more rapidly reversing flux.

Due to the fact the secondary current always flows in the opposite direction to the primary current it will oppose the magnetizing effect of the primary. The resultant flux in the strip is the difference between that which would be generated by the primary ampere turns and that of the secondary ampere turns.

If we again assume the current in the strip is condensed into three paths such as shown in B, the current in the outer path will enclose approximately all of the magnetic flux, and will tend to reduce the flux in the entire section. The current in the intermediate path will only tend to reduce the flux within its area which will be approximately ½ section of the strip. In like manner the inner current path only affects the flux within its area. All three current paths reduce the flux in the inner loop, the two outer current paths reduce the flux

Figure 10 — Schematic diagram of electrical equipment for induction heating of steel strip.



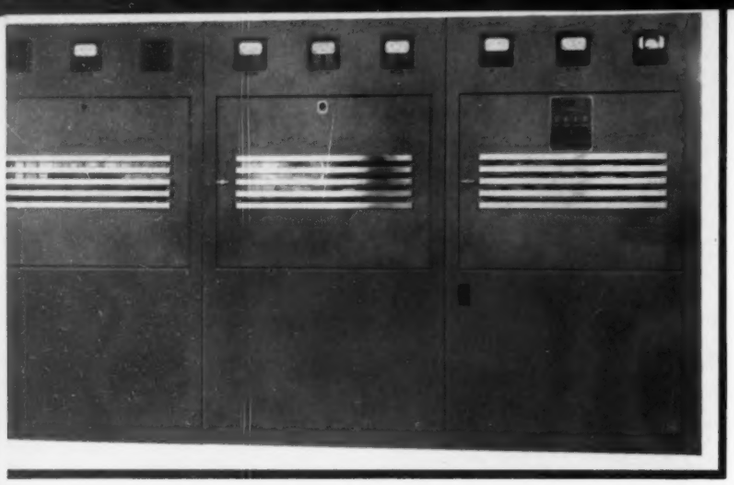


Figure 11 — Mercury arc rectifier tubes, reactors, capacitor unit, and oscillator tube are enclosed in steel cabinets.

within the intermediate circuit and the area between the two outer paths is reduced only by the outer current path.

This therefore crowds the flux to the outer surface as is shown in Figure 9, A. A graphic representation of this distribution is shown in the small curve to the right of A.

Under this condition of distribution of magnetic flux in the strip the current generated in the cross section of the strip will be determined by the amount of flux any current path encloses. Since we now have a concentration of the flux near the periphery of the strip there will be a still further crowding of the current to the outer circuit as is shown in the figure to the right of B. This not only shows a greater crowding of the current to the periphery of the strip but also an increased amount of the current over that obtained at low frequency as is shown in Figure 8.

Fortunately induction heating tends to maintain a stable condition of heating with variation in gauge whether it be across the sheet or along its length. The reason for this is that the secondary current which generates the heat in the strip is controlled by the amount of flux passing through the strip. If at a given instant the gauge of the strip within the inductor coil is less than normal, the amount of flux in the strip will be decreased with a resultant decrease in secondary power to heat the strip. On the other hand if the section in the inductor heating coil is overgauge there will be an increase in flux with a consequent increase in heat generated.

This characteristic makes it possible to operate with all sections of the tin heated within a very small range above the actual fusion temperature of tin. This in itself tends to reduce the possibility of oxidation even when the tin is flowed in an oxidizing atmosphere.

Another feature which may be an advantage for induction heating is the fact that the instant the strip leaves the inductor coil the cooling cycle begins and a start is made toward solidification of the tin as it approaches the liquid quench. This can be accelerated by blowing air along the length of the sheet between the quench tank and the inductor coil if desired.

These advantages of induction heating as well as that due to the fact that it is not necessary to have the strip contact metallic rolls or have current pass from the conductor rolls to the strip through the tin makes inductive heating attractive for this application, and tends to offset its increase in cost and lower efficiency.

Induction heating may also justify itself by a reduction in mechanical defects in the tin coating, which would reduce the cost of inspection and increase the per cent of prime sheets. This method of flowing tinplate may also permit higher speeds and the use of a thinner coating with the assurance that a given corrosion resistance value will be maintained.

The type of equipment used to generate high frequency energy is shown in Figure 10. Commercial frequency power is used to first develop high voltage direct current by means of a rectifier transformer and a mercury tube rectifier. This high voltage d-c power is maintained on a bus, to supply power to the tube oscillator circuits which generates the desired frequency and current for the inductor heating coil. In this particular diagram we have shown two oscillator tubes used in connection with the necessary reactors and capacitors to develop a frequency in the neighborhood of 200,000 cycles. The high frequency circuits are water-cooled and shielded to prevent interference with external electric circuits. Distilled cooling water is used, the connection between ground and the high voltage being made either through rubber tubing or through ceramic insulators. It is necessary to keep the water free of foreign material, otherwise the leakage current from the high voltage radio frequency circuit to ground would be too great.

The power input to the strip can be quickly and accurately controlled by means of an induction regulator, a saturable core reactor or by means of grid controlled tubes in the commercial frequency circuit.

The mercury arc rectifier tubes, the reactors and capacitor unit, as well as the oscillator tubes are usually enclosed in the steel cabinets such as shown in Figure 11. This is a front view showing three sections, one being used to house the rectifier tubes, the second the oscillator tube, and the third the reactor and capacitor units.

The inside of the steel cabinets are lined with copper to absorb radiation from the high frequency circuit. Interlocked doors are provided for easy access to the equipment in the individual cells.

A rear view of these cabinets with the doors removed is shown in Figure 12. The left hand cabinet houses the mercury arc rectifier tubes, the middle cabinet the oscillator tube and the one to the right the reactors and capacitors. The coil in the lower part of the right hand cabinet is the rubber hose used as an insulator and conductor of the distilled water for cooling the high frequency circuit.

It has been necessary to select equipment for flowing tinplate without the opportunity of giving the subject as much study as we would all like. In this paper, we have tried to describe two methods of electrically heating tinplate that may be used giving more attention to the inductive method due to the fact we have had little experience with it in the steel industry. We have tried to emphasize the advantages and possible disadvantages of each method as we see it from the electrical manufacturers points of view, realizing that the final method proving most appropriate can only be settled by experience on commercial lines.

In making a selection of apparatus to fuse tinplate,

in spite of the fact we do not have a great deal of experience to guide us, there are a number of rather definite facts that should be kept in mind.

1. The thickness of the tinplate coating is but thirty millionths of an inch, with the possibility of future developments making this still less. I do not know whether it is possible for us to obtain any physical conception of what this means, but it is 1-100th of the thickness of a human hair.

2. Tin is a soft metal that will not withstand much stress. This along with the fact that the thickness of the protecting coating is microscopic, means that it can withstand very little abuse.

3. The only logical place for fusion equipment is in the electrolytic line immediately following the electrolytic tanks. This avoids rehandling. Tin may be able to withstand mechanical abrasion due to handling a container weighing a few ounces empty and a few pounds when filled, but if handled in coils of several tons, we do not see how scratching the tin surface can be avoided.

4. If the equipment is to be installed in the electrolytic line the type of fusion equipment selected must lend itself to quick and accurate response to change in power requirements. This is necessary in order to obtain satisfactory and uniform fusion regardless of the speed at which the line is operated.

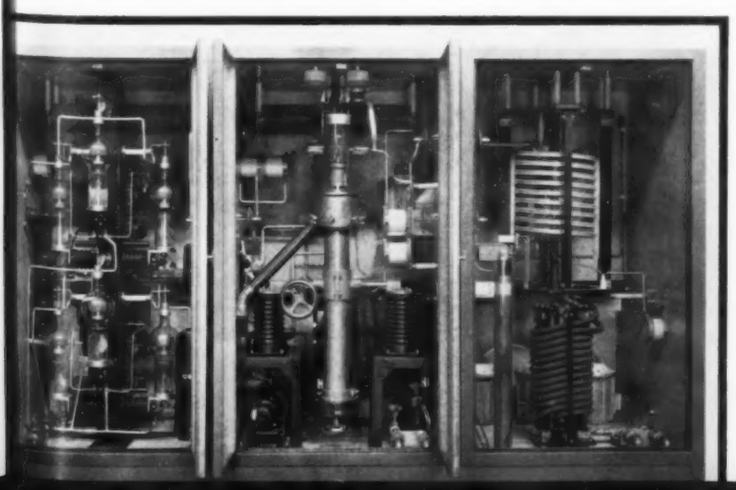
5. The type of equipment selected should contribute to as few defects in the tin coating as is possible. This would not be so important if we could feel sure that all of the defective sheets were removed in later inspection, but this is not easy to do.

6. The system selected will be of considerable value if it contributes to the possibility of reducing the amount of tin used per base box and still retains a satisfactory and uniform coating.

7. Average tinplate traveling at 500 fpm is being produced at the rate of 15 tons per hour. On the basis of the selling price of $5.00 per base box the value of the strip produced per hour is $1500. This is one of the last operations before shipment so that we are dealing with a product of considerable value.

A great deal of study has been made by members of the steel industry of this subject, and in many cases pilot plants have been installed to flow tinplate by one method or another. These companies are to be commended and congratulated for the contribution they are making to the industry as a whole on this very difficult problem which requires a prompt solution, and regardless of the method that may finally be used I am certain a practical one will be selected and a new development will soon be credited to the steel industry along with the many others they have made in recent years.

Figure 12 — View of cabinets with doors removed. Rectifier tubes at left, oscillator tube, center, and reactors and capacitors at right.



DISCUSSION

PRESENTED BY

E. T. LORIG, Design Engineer, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania.

E. W. HOPPER, Superintendent Tin Mill, Crucible Steel Company, Midland, Pennsylvania.

G. E. SHAAD, Industrial Engineer, General Electric Company, Schenectady, New York.

A. L. NIELSEN, Development Engineer, Sharon Steel Corporation, Sharon, Pennsylvania.

R. D. BANE, General Superintendent, Sheet and Tin Departments, Republic Steel Corporation, Warren Works, Warren, Ohio.

E. C. MARSHALL, Electrical Engineer, The Youngstown Sheet and Tube Company, Youngstown, Ohio.

G. E. STOLTZ, Manager, Metal Working Engineering, Industry Engineering Department, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

E. T. LORIG: In my opinion the induction method of heating has certain definite advantages which may eventually prove that system to be superior. In checking over the economics of the problem, there are various things which seem to indicate that the cost of producing will perhaps be somewhat greater than when utilizing conduction. There is so little information on either system before us at this time, it is very difficult to say which is the better and, as was mentioned, eventually one or the other is going to predominate.

As far as Carnegie-Illinois is concerned, for various reasons we are proceeding with conduction heating in our operations, and with fairly good results at present. I would like to stress the fact that it is not heating alone that makes for good coating. There are many other factors that enter into producing a good, bright coating which apply to both systems. I refer of course to processes previous to electro-plating. At the moment the economics of the conduction system seem to be superior to induction.

E. W. HOPPER: We are not prejudiced in favor of either method, but agree with the remark that it is not going to be a question of whether you can improve the surface very much by either one method of heating or the other. It is going to be a question of strip preparation and the tin plating. However, you can injure the surface; that very definitely can take place. I think possibly that might apply more to conduction than induction. We are not running into either problem

right now, but we are very much interested in it. I would like to hear some opinions in regard to conduction heating.

G. E. SHAAD: On the conduction type of heating there is not much we can add to what Mr. Lorig has already said. Their experience has been very much the same as ours. Our results have shown no particular problems that cannot be overcome, but at speeds in excess of 500 fpm no one can say that there are no problems involved in either type of heating.

A. L. NIELSEN: As many of you know, I have been engaged in the development of electro-tinplate for the past six years under the supervision of J. S. Nachtman. Our early experience showed us that the quality of the electro-deposited tin coating was very much improved by melting of the tin on base strip after electro-deposition. In 1936 we put a continuous electro-tinplating line into operation using an oil bath for brightening the tin. During the following year we made a thorough study of other means of brightening the tinplate, including both high frequency electric induction and electric conduction. Our experience and also the advice given us by the large electric companies led us to believe that electro-tinplate can be brightened by high frequency electric induction and by electric conduction, but that the cost of brightening by either of these methods would be much higher than the cost of brightening the tinplate with an oil bath.

During the past year we have been operating an experimental electroplating line wherein we have brightened electro-tinplate by various methods and at the present time I am, more than ever, convinced that the oil bath method of brightening as we have worked it out, is the best method of brightening electro-tinsplate. This conclusion is based on the low cost of installation, economy of operation, ease of control and high quality of final product.

According to the information I have, the cost of brightening by high frequency electric induction will be approximately six times the cost of brightening with an oil bath, while the cost of brightening by electric conduction will be about four times that of oil brightening.

In the oil bath the strip is at all times protected with a film of oil which protects its tin surface from mechanical damage by contact with the strip carrying rolls and from oxidation while in the molten state. The heat transfer in the oil bath is very rapid and yet there is no danger of overheating. In our experimental electroplating line we have operated at a speed of 200 fpm and then suddenly dropped the speed to 10 fpm without any difference in appearance of the finished tinplate; also the strip width can be varied at will. The strip as it passes out of the oil brightening system, has a bright mirror-like pure tin surface covered with a slight film of light oil which protects the tin surface in handling but which does not interfere in the least with soldering and lithographing of the tinplate.

We have noticed that the tin-iron alloy at the surface of the base metal has a great deal to do with the corrosion resisting properties of the tinplate. In the brightening of electro-tinplate by the oil method we find that we get sufficient alloy to give good bond between the tin and the base metal and that the tinplate will withstand deep drawing without destroying this bond. I doubt if this alloy is formed in the short time of melting as stated by Mr. Stoltz.

An oil bath for brightening electro-tinplate at 1000 fpm is commercially feasible. It would operate with little attention and maintenance, producing a uniform high quality of tinplate at minimum of cost per ton.

R. D. BANE: After giving the subject a good deal of thought, we decided to go along with the induction-method of flow-brightening, as it was the idea of our chief engineer, C. J. Duby, and his suggestion to Mr. Stoltz that this method of flow-brightening be gone into and given serious study.

E. C. MARSHALL: Mr. Stoltz has mentioned the difference in cost between the induction method and the conduction method — a difference between $25,000 and $150,000, and when you think of that difference in dollars, it is quite definitely in favor of the conduction electrical equipment. However, I do not believe we can draw a conclusion based on electrical equipment alone, for, as the paper states, the inductive heating system requires less machinery; accordingly less machinery consequently requires less floor space, less space in buildings, and that has to be taken into consideration as a factor.

I ask Mr. Stoltz whether the $25,000 for equipment is based upon single-phase or three-phase and if for single phase, what other equipment is contemplated? Formerly, tin mills consumed a considerable amount of power, ranging from 3000 to 6000 kva and as the contemplated strip heating requires between 600 and 1000 kva there will be excessive unbalancing if single-phase is employed.

To overcome that we have to go to a three-phase motor driving a single phase generator (a motor-generator set) or else a transformer having three phases. This will mean a little more money.

One other thing that comes to my mind: when in the line of strip, welding the tail end of one coil laps the end of a second coil which may be less in width; I do not see how you can have constant heat in those two sections of strip during the period of passing from the entrance conductor roll to the delivery conductor roll and in that distance there is considerable strip loss. That indicates a considerable advantage in favor of induction method. I also have in mind the ease of control by the induction method in that only a very small area of strip is involved. I would also like to hear from Mr. Stoltz something about tube life.

G. E. STOLTZ: We are at a crossroad where a decision must be made in regard to a new process. I remember the many interesting meetings the Association of Iron and Steel Engineers held 25 years ago on the subject of "Steam vs. Electric Drive." An announcement of a paper to be presented on this subject always drew quite a crowd, as there always seemed to be certain men who favored electric drive and others who favored steam drive.

Due to the difficulty of measuring the amount of steam used on a rolling mill with widely varying loads, not much was known definitely of the cost of rolling steel on steam driven mills. At first the same thing was

true with the electric drive due to the fact that they were just being introduced and little or no background of experience was available. At that time electric motors were installed merely to perform the same function that the steam engine performed. Experience was necessary to improve the method of driving the mills and also to develop new methods of rolling steel. Our discussions always centered around cost of operation.

Advantage was continually taken of the superior quality of electric drives until in many cases the method of producing the product was entirely different than that used in the old days of steam engine drives. Our continuous hot and cold strip mills are examples of this.

During the early years when electric motors were first being used to drive rolling mills no one would have suspected that today we would be rolling cold tinplate in tandem mills at the rate of 2000 to 3000 fpm. I certainly would not venture to predict the future of fusion of tinplate as this will only be known through experience. It is unfortunate that the majority of the tin ore has been taken away from us as this has forced the installation of equipment on a relatively new process without the experimental background we would prefer to have.

I am not familiar with Mr. Nielsen's installation, and appreciate his reference to comparative cost of operation with induction, conduction, and oil is overall, but in one case it has been reported that the electric power consumption for induction heating is practically the same as that for the electric power used to heat the oil where tinplate is brightened with oil. One reason for this is due to the heat loss carried away by the film of oil on the strip as it leaves the furnace, and another is due to radiation.

I am not an authority on metallurgical results obtained in fusion of tinplate, and can not state whether a satisfactory alloy is obtained between the tin and iron, but one manufacturer who has had an induction heating line in use for five months, operating up to 500 fpm has purchased additional induction heating equipment for three large lines. Certainly they would not do this if a good coating were not obtained.

In answer to Mr. Marshall's question, the $25,000 cost of conduction heating equipment refers to single-phase apparatus. This includes a heating transformer, saturable core reactor, the necessary circuit breaker, switching equipment and control. I appreciate there may be power systems, particularly small ones where a large single phase load would be objectionable. In this case it would be necessary to install a three-phase installation which would require more conductor rolls some of which would be in contact with the strip at temperatures above atmosphere. A balanced load on the power system for a single phase installation can be obtained by installing a three-phase motor driving a single phase generator. The power control to the strip would then be accomplished by means of adjustment of field current on the single phase generator.

The life expectancy of rectifier tubes is 3500 hours and the oscillator tubes 7000 hours.

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The Blast Furnace Skip Hoist

. . . . setting forth a recent design of skip hoist using an inverse-torque drive, with high gear ratio and generally simplified mechanical composition . . . .

by GORDON FOX

FREYN ENGINEERING COMPANY

CHICAGO, ILLINOIS

▲ OCCASIONALLY it is well to revert to fundamentals, to re-examine practices and to question the inviolability of precedent. The topic in hand is approached in that vein.

Let us first have a look at the mechanism of the blast furnace skip hoist. Here the story of its development may suggest a trend.

The steam hoist used at the early blast furnaces employed a low-speed engine driving through a single gear reduction. Electrification involved the substitution of a motor. As the speed of a suitable motor was higher than that of the engine, a double gear reduction was introduced. More recently, some of the advantages afforded by the two-motor drive have been recognized. Therefore, the single-motor has been supplanted, in many instances, by two mill type motors. This change could be made by the hoist builder with a minimum of mechanical adaptation if the two motors drove through a common gear train, such as had formerly served for single-motor drive.

A recent new design of skip hoist extends the trend. This design accepts the superiority of the two-motor drive as a premise. It seeks to incorporate this type of drive most effectively as an integral element of the hoist design rather than an adaptation. Symmetry is the predominant note in this design which bears considerable resemblance to a motor-generator set in its mechanical composition. Complete duplication of the drive media, including motors, brakes and gearing, is another new note. The employment of standard gear units is a third departure from the conventional. A still further striking change in design concerns the use of a much higher gear ratio. The reasons for this change will be later discussed.

The several stages in the development of the blast furnace skip hoist are indicated in Figure 1. The appearance of a hoist of the new type is shown in Figure 2 and a control panel is shown in Figure 3.

To obtain a proper perspective toward the question of motor application to blast furnace skip hoists, it is well first to consider the magnitude of the task to be performed. A simple calculation shows that the average expenditure of power required to lift all necessary materials to charge a typical thousand ton furnace is only about 40 to 50 hp. In view of the fact that the charging is a batch process, rather than a continuous one, the horsepower requirements are obviously higher during the periods when hoisting is in progress. Furthermore, because it is necessary to accelerate and decelerate the hoist elements as well as the skip tubs and the material handled, additional power requirements enter the picture. However, taking these factors into consideration, the total root-mean-square load of a typical skip hoist for a large blast furnace is substantially less than 100 hp.

It should be obvious then, that, if the root-mean-square or heating load were the only criterion, the use of motors of several hundred horsepower capacity to drive blast furnace skip hoists could hardly be justified.

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 22-24, 1942

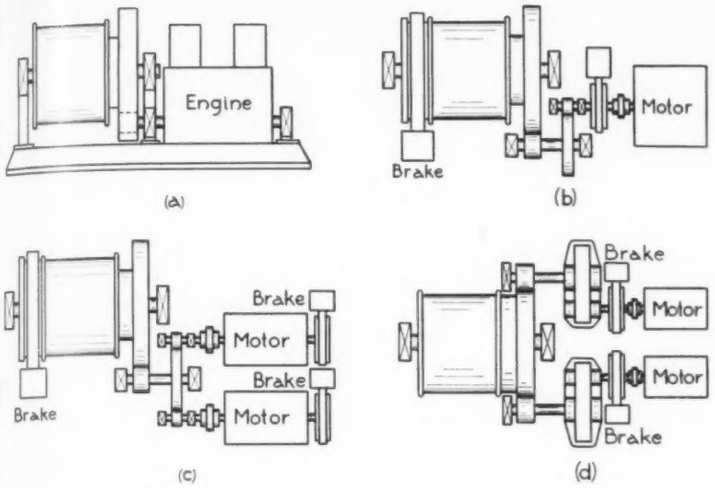


Figure 1 — Sketch showing steps in the development of the blast furnace skip hoist.

What, then, is the factor that dictates the size of motors required for these hoists? It is primarily a question of torque.

Since torque is the ruling consideration, it behooves us to study the nature of the torque requirements and the conditions which influence the torque demand. As the majority of blast furnaces are charged by two "balanced" skips, we will concern ourselves with this mechanism.

Two skips are balanced to the extent that the weight of the down-coming skip approximately compensates for the weight of the ascending skip. This relation holds during the mid-portion of the skip trip, but it does not apply near the ends of travel. A glance at Figure 4 shows that, when a skip capsizes at the top of the furnace, the center of gravity is almost directly above the wheels and the pull on the cable is very slight. Because of this fact the torque required at dumping diminishes rapidly as the skip capsizes. Moreover, when starting the next succeeding skip trip, the skip at the top of the furnace does not exert an appreciable counterbalancing effect until the cycle is well under way.

Furthermore, if the skip incline is more steep in the skip pit, a rather common arrangement, the pull of the down skip is substantially greater at starting than at mid-travel. The weight of the cable is also greater on the side of the down skip.

Because of these relationships, the torque conditions at the beginning of travel are entirely different from the torque conditions in mid-travel. Figure 5 shows how the torque requirements change during the cycle. Referring to a typical coke load, it will be noted that the torque demand at the instant of starting is more than twice the torque demand in mid-travel after balanced conditions have been established. If we include the torque required to accelerate the hoist and the load, the torque requirements are as shown by the dotted line, further accentuating the disparity between the starting and the running torque requirements. Referring to a typical ore load, the relationships are similar, though differing somewhat in magnitude and degree.

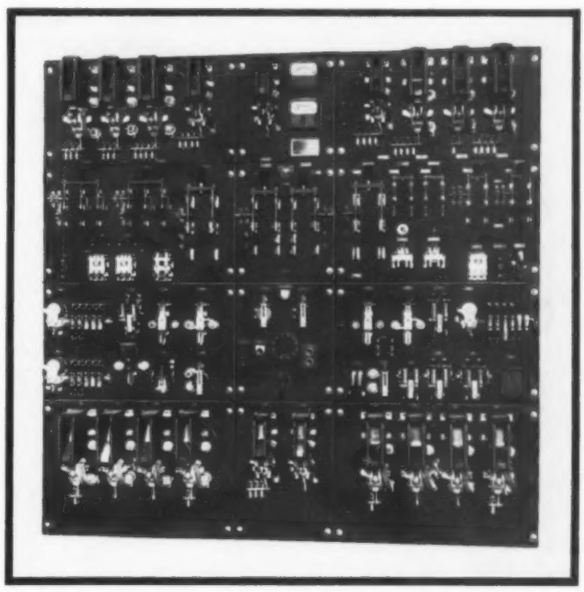


Figure 3 — Series-parallel blast furnace skip hoist control panel.

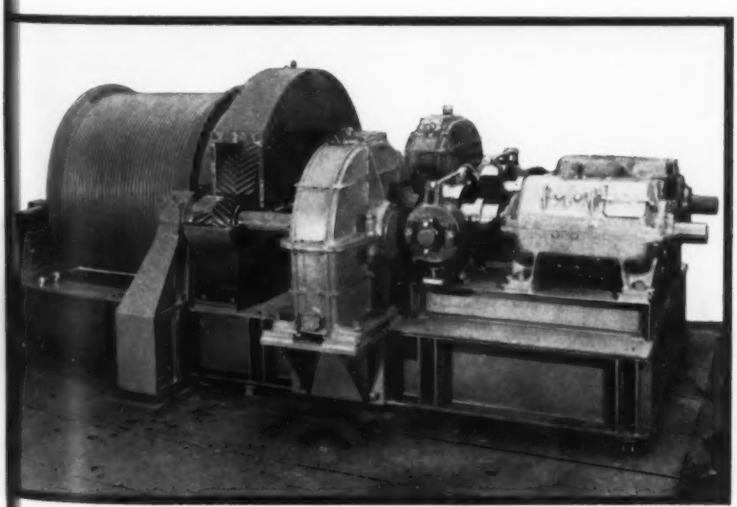


Figure 2 — Dual drive single drum skip hoist.

This figure and this explanation would seem to be adequate justification for the statement that the usual blast furnace skip hoist has an inverse torque requirement. A high torque is required at low speed, in starting, whereas a greatly reduced torque is adequate after the skips have reached their balanced condition and full speed has been attained.

Most conventional skip hoist drives have had inherent constant-torque capacity, modified in a measure, in some cases, through the use of a series field which is

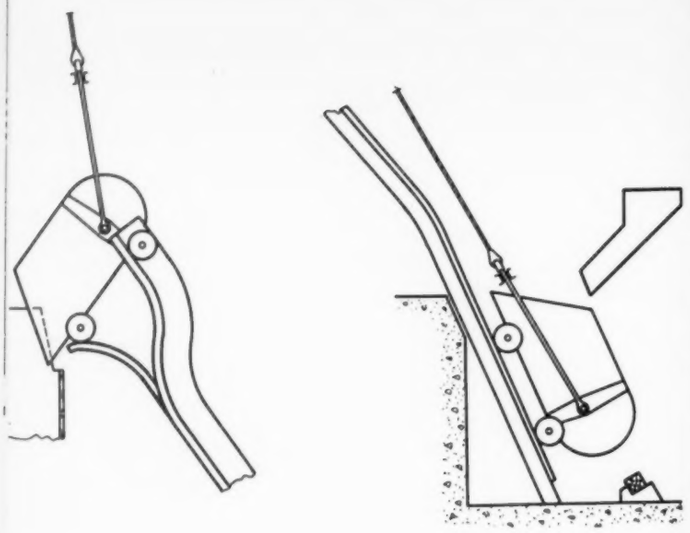


Figure 4 — Skip tub positions at both ends of travel.

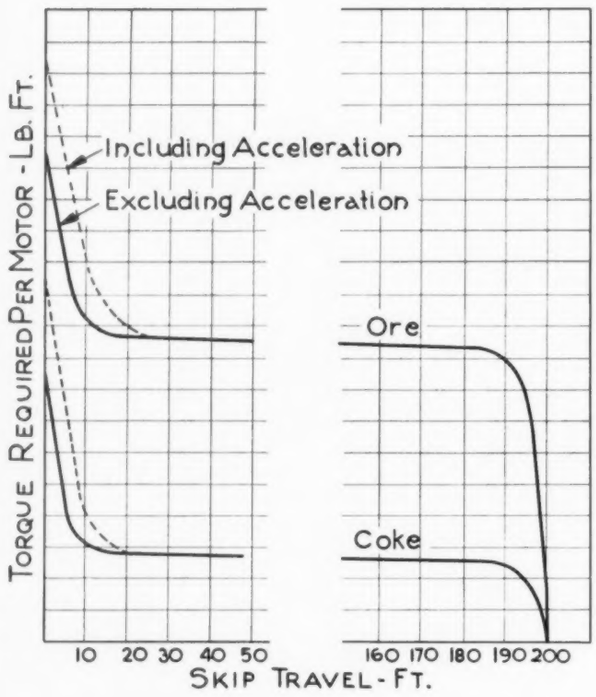
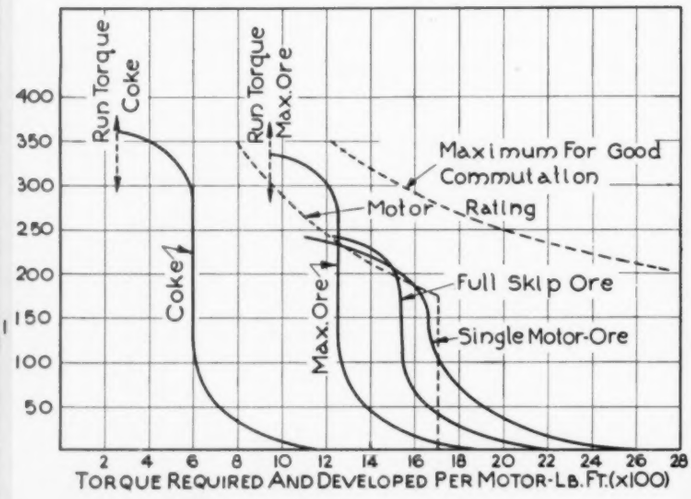


Figure 5 — Torque cycle of blast furnace skip hoist.

Figure 6 — Torque-speed diagram of blast furnace skip hoist.



short-circuited after running speed is attained. To obtain sufficient starting and accelerating torque, with such a drive, two courses may be followed, namely:

1. A motor may be installed which has an excess of torque above running requirements but which is thus enabled to meet starting requirements. In other words, a substantially oversize motor may be installed, or
2. A motor may be installed having suitable torque capacity to meet running requirements. Such a motor will be severely overloaded in meeting starting torque requirements.

Prevailing practice has generally been a compromise between these two courses. There is some justification, therefore, in describing the result as of compromise character.

Since starting torque is a dominant factor, the following course would seem to be logical.

1. Enable the motor to develop its maximum torque at low speed. As a step in this direction, we may force the fields, thereby realizing maximum torque per ampere of armature input.
2. Minimize the torque requirement at the motor, corresponding to a given torque requirement at the hoist drum, by increasing the leverage through which the motor torque works, that is, by increasing the gear ratio.

It should be obvious that, if the gear ratio is doubled, only half as much torque need be developed by the motor. Combining this with field-forcing, the result is attained that a smaller motor frame is fully adequate. Furthermore, the starting currents required to meet the minimized torque demands are extremely modest.

Perhaps it will now be conceded that doubling the gear ratio alleviates the high torque demand at the motor at starting. But what does this high gear ratio mean under running conditions?

It means that the motor must run faster; at perhaps 900 rpm instead of 450 rpm, its basic speed. A speed such as 900 rpm is little more than half the maximum safe speed of the mill motor armature and is well within the limits of established practice.

How can this 900 rpm speed be attained? By weakening the motor field. To be sure, this decreases the torque capacity of the motor at the higher speeds. But we have just pointed out that the torque requirement under full speed running conditions is relatively low.

The drive, then, comprises two mill-type motors, shunt-wound, operated with fields forced at starting and with fields weakened when running. Such a drive has inherently an inverse torque characteristic suiting it ideally to the task in hand.

The torque relations may perhaps be further clarified through inspection of Figure 6. This figure illustrates how the torque requirement decreases as the upper skip is righted, how it holds at an intermediate value during acceleration and how it falls off to a relatively low value as full speed is attained and the factor of acceleration fades out of the picture. The figure also shows how the rated torque capacity of the motor corresponds to the torque requirements of the load, under both starting and running conditions.

While this figure is in mind, it may be well to note that it is a relatively easy matter for a drive of this kind to handle an unusually heavy load, such as a full skip of ore. By restricting the top speed of the motor, under such conditions, the high torque capacity at low speed is made available for the entire hoisting cycle, this torque being applied at a most advantageous gear ratio. The heavy load can thus be hoisted without appreciably overloading the motor.

Similarly, if and when it should become necessary to drive the hoist temporarily with a single motor, the ability of that motor to handle the load is greatly enhanced by reason of the high gear ratio. To be sure, the torque developed by the single motor under weakened field conditions might prove inadequate but if the running speed be restricted by weakening the fields to a lesser degree, the single motor develops torque adequate to this exceptional duty.

In the conventional two-motor drive having constant torque characteristics, the single-motor capacity of the drive is very limited unless decidedly oversize motors are used or unless the single motor is greatly overloaded. The inverse-torque drive with high gear ratio can provide adequate single-motor performance without recourse to either of these expedients.

The general principles of the control of this new skip hoist drive are shown in Figure 7. The control employs the series-parallel connection, with which you are familiar. It supplements this combination with field-forcing and field-weakening. By this means a rather wide range of operating speeds is obtained without the use of armature circuit resistors. The hoist is started with motors connected in series and with the fields forced. The speed is doubled by transition to the parallel connection. The speed is further increased, to the running value, by field-weakening. When the slow-down points are reached, the fields are again strengthened and the motors are again connected in series. The sequence of the changes at slow-down is adapted to afford the particular slow-speed steps desired.

The relations between the hoist cycle and the control steps are indicated in Figure 8.

The new control differs from previous two-motor series-parallel drives partly in that the running speed and the upper half of the speed range, are obtained by increasing the speed above the parallel basic speed by weakening the shunt fields of both motors. The lower half of the speed range is secured through the series-parallel connection. This contrasts with previous practice in which the series-parallel connections provided the upper half of the speed range, and the speeds lower than those afforded by the series connection were secured through the use of main circuit resistors.

The motors employed for this drive have shunt, stabilized field windings. When the motors operate in parallel, under running conditions, the stabilizing windings are in circuit. The shunt fields may then be weakened with impunity. The stabilizing windings are made rather strong, as related to the weakened shunt fields, thereby imparting to the motors a drooping speed characteristic sufficient to insure satisfactory load division between the two motors. When the motors are connected in series, the stabilizing windings serve no useful purpose; in fact they would tend to impart a drooping speed characteristic which is undesirable dur-

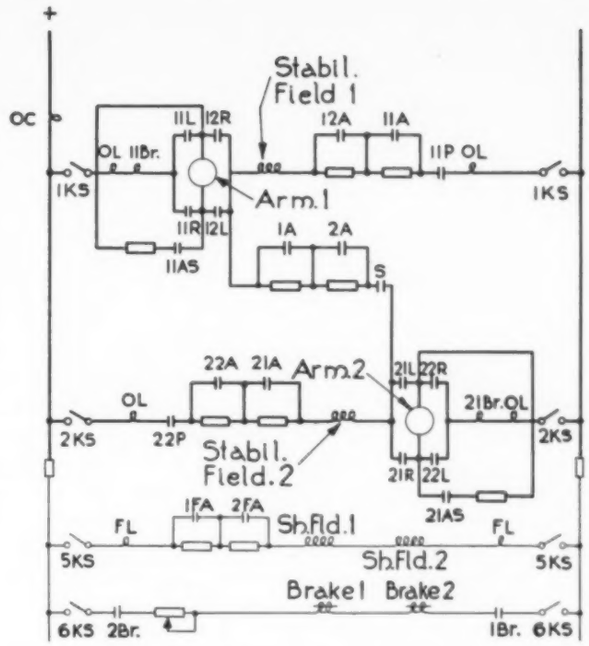


Figure 7 — Schematic diagram showing principles of control of new skip hoist drive.

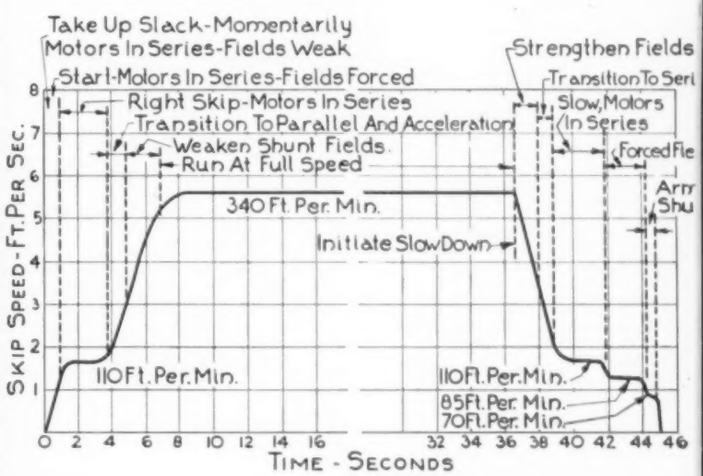
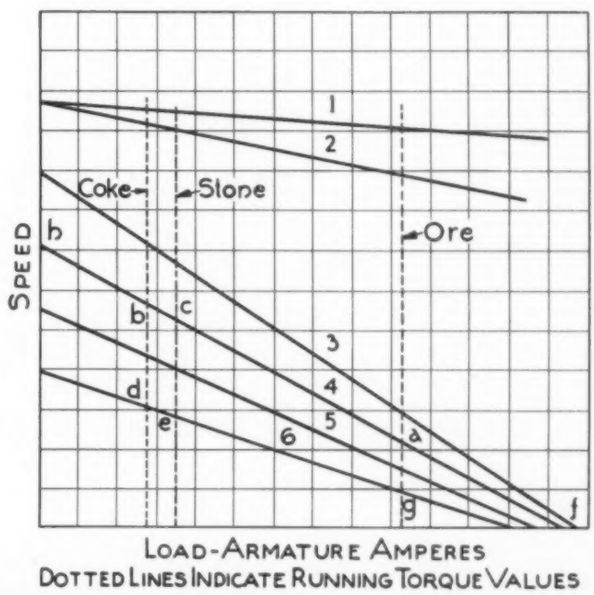

Take Up Slack-Momentarily
Motors In Series-Fields Weak
Strengthen Fields
Start-Motors In Series-Fields Forced
Transition To Seri
Right Skip-Motors In Series
Slow, Motors (In Series
Transition To Parallel And Acceleration
Weaken Shunt Fields
Forced Fie
Run At Full Speed
Arm Shu
340 Ft. Per. Min.
Initiate Slow Down
SKIP SPEED-FT. PER SEC.
110 Ft. Per. Min.
110 Ft. Per. Min.
85 Ft. Per. Min.
70 Ft. Per. Min.
0 2 4 6 8 10 12 14 16 32 34 36 38 40 42 44 46
TIME - SECONDS

Figure 8 — Speed-time curves for blast furnace skip hoist.

Figure 9 — Speed-load relations for skip hoist drive using single motor and rheostatic control. Curve 1 — Full speed as shunt motor. Curve 2 — Full speed as compound wound motor. Curves 3, 4, 5 and 6 — Armature shunt points.



ing slow-down. Therefore, the series connection between the two motors excludes these fields.

The procedure in this new control is just the inverse of that in the conventional single-motor rheostatic control in which the series field was connected in circuit only during the starting and slow-down periods.

It may have been noted in Figure 7 that one step of armature shunting resistance is provided. This may be employed to secure a speed point lower than that afforded through connection of the motors in series, with their fields forced. This arrangement affords a further advantage in that it permits of adjustment of the minimum slow-down speed. In any case only a relatively small reduction of speed is secured by this means so that the disadvantages which ordinarily accrue to the armature-shunting expedient are minimized.

The two armature-shunting contactors and resistors which are employed to provide one speed step, when two motors are in normal use, may be applied to either motor to provide two steps of slow-down when one motor is used singly.

The armature-shunting resistors may serve a further useful purpose by providing a transient dynamic braking effect when the hoist stops.

An inherent deficiency of the single-motor drive with rheostatic control was the poor speed regulation at dumping speed resulting from the fact that a speed reduction as great as 3 or 4 to 1 had to be secured through the use of armature series and shunt resistors. To offset the deficiencies of poor speed regulation at dumping-speed, which causes a coke load to dump at a higher dumping-speed than an ore load, various methods were improvised to introduce differing amounts of resistance proportioned to the weight in the skip. Such arrangements necessitated a substantial number of armature shunting points and more or less complication in the way of discriminating relays responsive to the load being handled. A further objection to this method of control rested in the fact that because armature shunt and series resistors played an important role, heavy currents were involved. These currents were objectionable in that they represented substantial losses in power. They required the use of large banks of resistors to dissipate this power. These became hot and required maintenance. Furthermore, the contactors on the control panel were called upon to handle and to interrupt heavy currents.

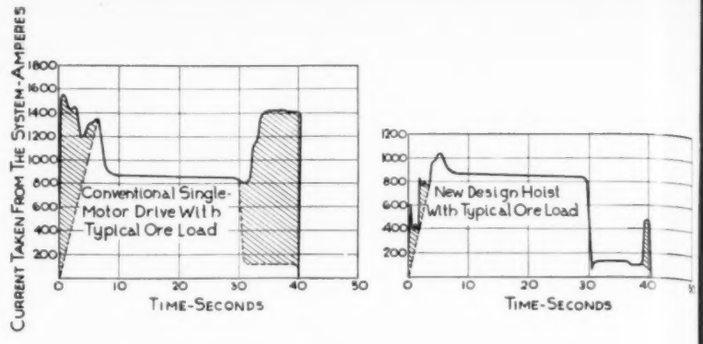


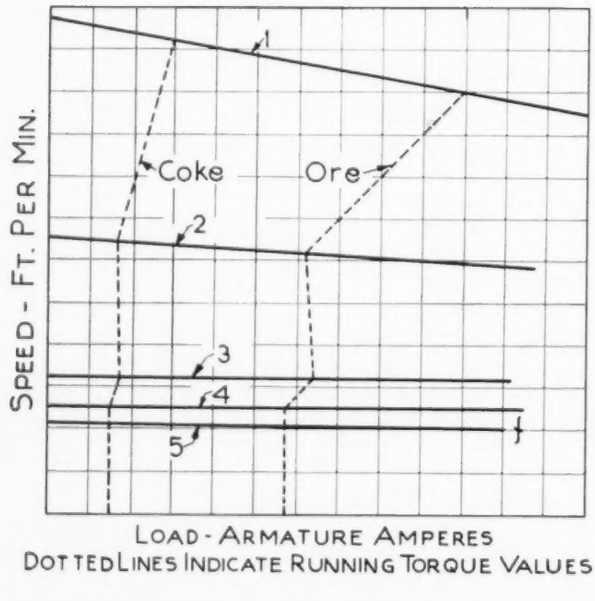
Figure 11 — Comparison of current inputs for blast furnace skip hoist drives. Shaded areas indicate rheostatic losses.

The character of the speed regulation which was obtained with a drive comprising a single, compound-wound motor with rheostatic control is shown in Figure 9. Curve 1 shows the free-running speed with the series field short-circuited. Curve 2 shows the effect of the series field. Curves 3, 4, 5 and 6 show four shunted-armature steps. At point "a" on Curve 4, a satisfactory dumping-speed is obtained with an ore load, but if this same stop were used for a coke load, dumping speeds "b" or "c" respectively would result. These are too high; hence, additional armature shunt steps are required. On step 6, points "d" and "e" are obtainable. These correspond rather closely to point "a." Thus it is seen that different slow-down steps were required with ore and with coke and stone unless the ore load was slowed down excessively, as indicated by point "g" on Curve 6.

It should be noted that the maximum load which could be handled was only slightly greater than the normal ore load, as indicated by point "f," at which the motor stalls.

It should also be noted that when the upper bucket capsizes and thus decreases the load on the hoist, there is a strong tendency for the dumping-speed to increase. For instance, when handling ore with dumping speed "a" on step 4, capsizing of the bucket will cause the speed to increase toward point "h." Thus, just at the

Figure 10 — Speed-load relations for new design of skip hoist drive. Curve 1 — Stabilized shunt motors, weakened fields. Curve 2 — Stabilized shunt motors, slightly weakened fields. Curve 3 — Shunt motors in series, slightly weakened fields. Curve 4 — Shunt motors in series, forced fields. Curve 5 — Same as (4) with light armature shunt.



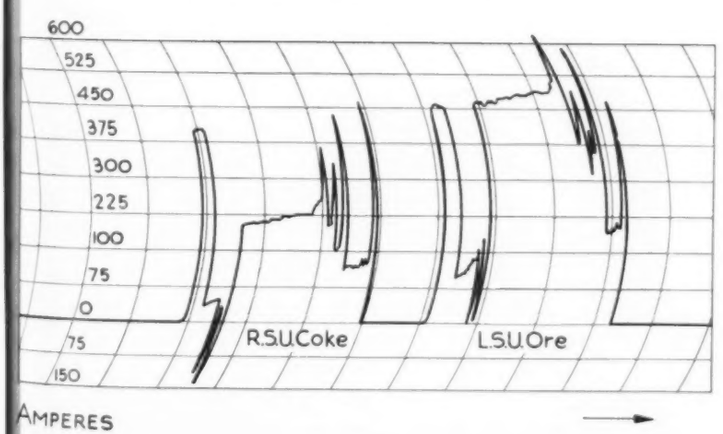
time that the hoist is to be stopped, it starts to accelerate and the speed from which the stop is made, is indefinite. Inaccurate stopping is the natural result.

By way of comparison, Figure 10 shows the speed regulation results obtained with a drive of the new type. Curve 1 shows the running speed with the motors operating in parallel, stabilized and with weakened fields. The speed regulation is somewhat drooping, insuring good load-division between the two motors operating in parallel. A coke load will have a full running-speed about 110 per cent of that for a normal ore load. As a result, the total trip time for a coke load will be about 2 sec, or 5 per cent less than that required for an ore load.

Curve 2 shows the speed obtained when two motors operate in parallel, the shunt fields being only slightly weakened. This is a running condition which applies temporarily in starting. Curve 3 is the intermediate speed used in starting, while the upper skip is righted, and also for the first step of slow-down. During this step the motors are connected in series and the shunt fields are approximately at their basic strength, but slightly weakened. Curve 4 is the creeping speed which results when the two motors, with forced shunt fields, are operated in series. Curve 5 is the dumping-speed obtained during the last 2 or 3 ft of travel by a single light armature shunting step. It should be particularly noted that the dumping speed is practically identical for an ore load and for a coke load, and there is no tendency for the hoist to accelerate as the upper skip capsizes. The hoist stops always from the same definite speed, with a high degree of accuracy. In brief, this drive has good inherent speed regulation at the dumping-speed, where speed regulation is important. It has drooping-speed regulation at full speed, where such a characteristic is advantageous. This is the inverse of the result afforded by conventional rheostatic control types of drives.

The adequacy of torque development after the skip reaches the knee of the incline, where the dumping-speed is required, is shown in Figure 10, in which point "f" is far off the page to the right (compare with Figure 9).

Figure 12 — Graphic chart showing system current input to two-motor drive of new type.



At this juncture a word about brakes may be in order. It has long been the practice to provide two brakes on blast furnace skip hoists. Initially one brake was applied at the motor shaft and another brake on the intermediate shaft of the one gear transmission. As an improvement upon this practice the second brake was applied to the hoist drum. For the single motor drive, this is the most rational arrangement.

When the two-motor drive was introduced, a third brake entered the picture, somewhat in the role of the unwanted child. It was hardly logical to supply a brake on one motor and not on the other. And the drum brake was considered desirable because the two-motor brakes were, in large measure, dependent upon a single intermediate mechanical transmission.

A further word may be said in defense of the provision of three brakes on the conventional two-motor skip hoist. Due to the low-gear ratio prevalent between the hoist drum and the motor shafts, relatively large brakes are required and there may be some merit in apportioning the necessary braking capacity between the two units.

In view of the fact that the gear ratio of the new two-motor hoist is about double that of the conventional two-motor hoist, the brakes which are applied at the motor shafts of this new hoist enjoy a large mechanical advantage. Consequently, moderate sized brakes can exert powerful holding torques at the drum shaft. With this drive it is an easy matter to provide two brakes either of which, acting alone, can handle a full ore skip at any point on the incline. Two such brakes acting in unison, can exert such decelerating torque that the addition of a third brake is neither necessary nor desirable from the viewpoint of torque capacity.

Further, since the new skip hoist design provides two completely independent drives, full duplication is afforded. Two adequate motor shaft brakes function through duplicate full-capacity transmissions, safeguarding the hoist while standing in the same measure that it is safeguarded while running.

In this new skip hoist design the drum brake can serve no useful function. The simplification resulting from its omission is therefore a net gain.

I will ask you to consider with me one further attribute of the new type of two-motor skip hoist drive and control. This attribute concerns the relatively low consumption and demand for electric power. Figure 11 indicates the nature of the electric power requirement of a conventional single-motor rheostatic type of drive. This curve is based on a graphic chart. The portions of the electric power consumption which must be dissipated in resistors during the starting and the slow-down periods is shown shaded. Figure 11 shows similarly the electric power input of a two-motor drive of the new type.

The two curves are drawn to the same scale and represent the hoisting of the same load at the same speed. The power required during the mid-portion of the cycle is the same in either case, but the power required during the slower speed portions of the cycle is quite different with the two schemes of drive and control.

It may be of interest, in this connection, to inspect a graphic chart showing the system current input into a two-motor drive of the new type. The chart shows an ore load cycle and a coke load cycle. It should be noted

that the average current input into the two motors combined is only about 400 amperes during the ore cycle, the highest momentary peak is only 600 amperes and the current intake in starting is less than the running load. These modest figures, particularly the absence of heavy current peaks in starting and at slowdown, substantially reduce the requirements of this type of hoist as to the direct current supply and the feeder copper required.

It may be permissible to state that this graphic chart does not represent the best that can be attained from a hoist of the new type. It shows results achieved on the hoist bearing serial Number One. Certain refinements incorporated in hoists subsequently constructed, should yield yet better results.

The power consumption of a blast furnace skip hoist is not a significant item when expressed in terms of kwhr per ton of iron and its cost is but a minute part of the cost of conversion. Nevertheless, the very substantial reduction of power loss in main circuit resistors, indicated in Figure 11, integrated over a year, may be of the magnitude of $1000. If such a worth-while saving be extended over the life of the hoist, the amount saved will exceed the initial cost of the entire electric drive equipment. In other words, an inefficient drive for a blast furnace skip hoist is not an economic purchase at any price.

This discussion of blast furnace skip hoists is far from complete. Nothing has been said about the single-motor rheostatic control which incorporates some range of adjustable speed. Little has been said about the conventional two-motor series-parallel drive. Each of these schemes has its merits but each also has its deficiencies.

Furthermore, nothing has been said about Ward-Leonard control, and much might be said on that topic. Nor have I mentioned the question of skip hoist speeds and the coordination of the hoist movements with other charging operations. Were I to attempt to cover all of these questions, the topic might be exhausted, but I fear that you would be even more exhausted. Perhaps these aspects of the subject can be discussed on another occasion.

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Nicking AND Breaking Billets INTO Shell Blanks

. . . . almost exclusively a wartime activity, billet nicking processes have been improved in step with the general improvements in the processes of shell manufacture . . . .

by G. V. SLOTTMAN *and* R. F. HELMKAMP

AIR REDUCTION SALES COMPANY

NEW YORK, NEW YORK

▲ THE fragmentation characteristics of steel used for explosive shells and bombs is utilized in the nick-break method of severing billets into shell blanks, following procedures developed during World War I and further improved within the last year. At present the great majority of shell blanks are produced by oxyacetylene nicking of billets preparatory to their being broken at the nicks by means of a press or ram. Since the nick-and-break process is essentially a very simple one, variations are numerous and there is considerable opportunity for effecting increases in production speed either by setting up oxyacetylene torches in multiple or by improving the handling facilities. While nicking machines have been made with as many as fifteen torches operating simultaneously, other features of the production set-up sometimes dictate other means for increasing output.

Billets for shell manufacture range in size from less than 3 inches to 12 inches square. It is sometimes found economical on sizes less than 4 inches to flame-cut the billets rather than resort to the double operation of nicking and breaking. In general, however, the unnecessarily high oxygen consumption in cutting does not warrant its use. Moreover the natural fracture resulting from nicking and breaking permits inspection for defects more easily than in the case of a flame-cut surface, which must be etched to show up defects for inspection.

While there are a number of other methods for severing billets, experience has shown oxyacetylene nicking to be most rapid and economical. Several attempts to substitute machine tool grooving have met with little success because this procedure fails to set up the internal stresses necessary to promote a sheer break. A particular advantage of oxyacetylene nicking is the comparatively small investment in equipment required, even where a large multi-torch machine is employed. Because only a shallow nick is needed the torches move at fairly high speed, and consumption of oxygen and acetylene is proportionately small.

Since nicking may be done either manually or by machine, the nature of the subsequent operations usually determines which of these two methods shall be used. Where the shell stock blanks will be heated in a rotary furnace after severance, they must stand on end and therefore a reasonably square end is essential. Likewise a square end is required where a piercing punch is employed for forming. It is evident that nicking by machine rather than by hand will produce the squarest break.

Manual nicking holds an important place, however, and is practiced in some plants where the capacity of the breaking machine, furnace or forming press would be insufficient to keep pace with the rapid output of a nicking machine. Since manual nicking is generally practical only when the billets are to be nicked on one face, rather than on two opposite faces, its application is favored by the use of steels of at least 0.35 carbon, which will fracture more readily. Where it is not essential that ends be square, manual nicking on one face

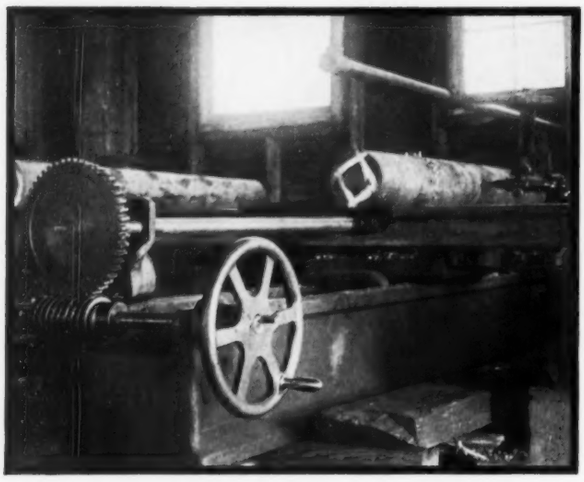


Figure 1 — During World War I this oxyacetylene nicking machine prepared round billets for breaking up into shell blank lengths. Billets were also nicked with hand cutting torches.

only is generally found to produce a satisfactory break.

In addition to its greater speed and accuracy there are other factors which favor the use of machine nicking. Whenever the billets must be double nicked, i.e., on two opposite sides, two-torch machine units are called for. Double nicking may be required either for the aforementioned reasons of squareness of break or because either the large-cross-section of the billet, the analysis of the steel, or the inadequate power of the breaking press requires two nicks instead of one.

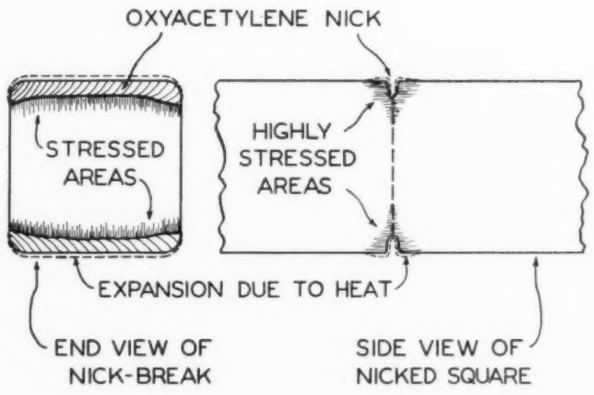
A combination of nicking and complete cutting as practiced at one mill is to first flame-cut the billet into double shell-blank lengths, then pass these on to the nicking machine which nicks them at the mid-point for subsequent breaking. Two and sometimes three cutting machines are required to keep the nicking machine busy. This method provides one natural fracture end on each blank, for inspection, and one square end for standing the blanks vertical in the furnace.

Before describing the procedures and the various types of machines in use at certain plants, a brief explanation should be given of the reaction set up in the metal by the nicking flame. In the application of the oxyacetylene flame on cold billets the high local temperature of the oxygen cutting reaction causes local expansion of the metal. Due to the physical restraint of the base metal, the metal adjacent to the nick or groove is upset. This effect, combined with the quenching action of the cold mass of metal, causes the adjacent areas to be highly stressed. In practice a water quench is sometimes used to intensify this reaction. The subsequent application of shock or pressure at the nicked points easily brings the metal beyond its elastic limit, and the resulting fracture is usually square and sheer, as shown in Figure 3. Thus the ready breakage of the billet at the lines of demarcation is promoted as much by the inner stresses set up by the nicking process as by the fact that the billet is slightly narrower at those points. Depth of nicking need never be as much as an inch, and ranges usually between $\frac{3}{16}$ and $\frac{3}{4}$ of an inch, depending upon billet size.

In general the differences in procedure employed at different plants are at least partially determined by the analysis of steel being worked on. Since shell steels are not all alike in composition, the fabricator should conduct experiments on the particular material to be worked on, to ascertain whether nicking on two sides is necessary or whether one-side nicking will result in satisfactory breaks. Also the depth of groove required should be determined by test.

Both round and square billets are used for shell stock blanks. They are hot sawed or flame cut, at the mill, to lengths of the required number of multiples of the shell blank length plus allowance for nicking kerf widths. This overall length is governed by the capacity of the billet-table or bed upon which the nicking or cutting is to be done. At one plant where an initial inspection of each billet for pipes and other defects is required, an additional 18 to 24-inch length crop is allowed at one end. This cropped section, after cooling, is manually nicked on two sides, as shown in Figure 5, and is broken on a guillotine. The fractured ends are then inspected for possible defects before the billets are accepted as shell stock material.

Figure 2 — Diagram of square billet showing stresses produced by oxyacetylene nicking on cold steel of 0.35 carbon and over.



Accurately cut to length, the billets are cooled on a hot-bed to between 1000 and 1100 F, and are then stacked in annealing boxes for slow cooling to around 350 to 400 F. At this temperature they are sufficiently cool for surface working. Transferred to open beds they are worked over with oxyacetylene deseaming torches to remove surface defects such as cracks, seams, scabs, etc. With this final preparation the billets are ready for the nicking operation.

Where nicking is done by hand the simplest procedure is for the torch operator to sit astride the billet and make his nicking cuts along chalk lines scribed at a measured intervals, such as shown in Figure 7. A refinement practiced in one plant is to lay the billets in groups of two on a low bed. Their elevation is such that the operator may straddle and ride the billets conveniently, seated on a roller carriage traveling along the tops of the two billets. A crossbar affixed to the front end of this carriage is used as a guide for the torch, and the operator moves quickly along the billets from one nicking position to the next by foot propellance. A standard 90 degree head hand cutting torch is used, held in such a position that the slag does not blow back to clog the tip orifices.

Generally, a nick of $\frac{3}{16}$ to $\frac{1}{4}$ inch depth is sufficient to produce a clean break under the hammer, bulldozer or press after the billet has cooled. Manual nicking is confined for the most part to the smaller and medium sized billets, although it has been found possible to obtain fairly satisfactory results on 12-inch squares by hand nicking one face to a depth of $\frac{3}{4}$ to 1 inch.

An idea of the productive output of manual nicking is given by data observed at one plant where an operator working on 4 by 4 inch square billets turned out 1000 nicked shell blanks in an 8-hour period. Oxygen consumption was 528 cubic feet, or roughly $\frac{1}{2}$ cu ft per nick, operating at a pressure of 25 pounds.

It is in machine nicking that a greater variety of method is found. Small billets which are to be nicked on one side only may be handled in rows, with the torch carried by a standard cutting machine traveling on a gantry track. The set-up is similar to that illustrated in Figure 8. A heating torch travels ahead of the nicking torch to preheat the rounded corner of each billet in turn, so that the nicking torch may travel without interruption from one billet to the next. After the machine has crossed the entire row the gantry track is moved down to the next nicking position, and so on until the billets are all nicked at every interval. The entire bed of billets is then removed and a fresh lot is brought in. This method is not limited to the use of a

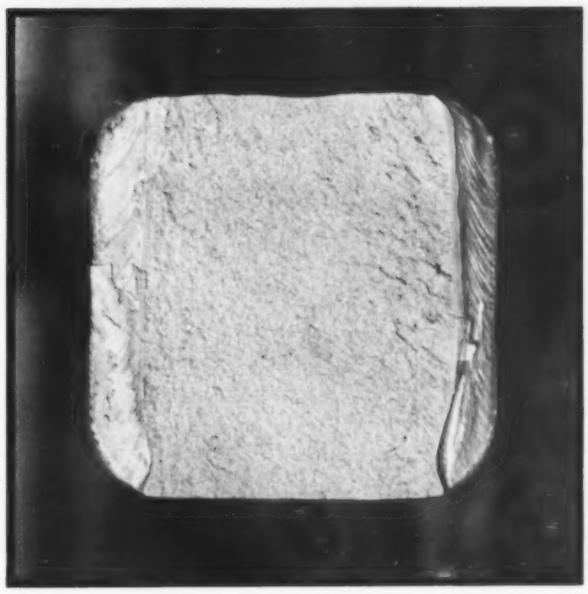


Figure 3 — End-on view of natural fracture resulting from nicking and breaking. Break is sheer and square, permitting accurate centering of forming punch.

Figure 4 — Hot sawing of billets to predetermined lengths of 21 feet 8½ inches, an exact multiple of shell blank length.

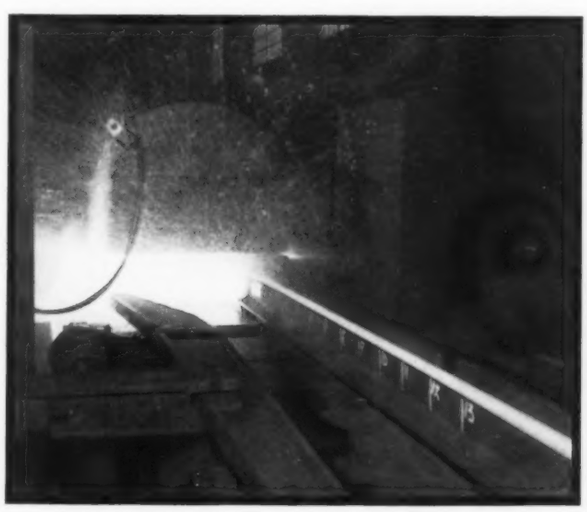


Figure 5 — Where each billet is inspected for defects, a crop end is manually nicked, then broken on a guillotine. This operation is separate from the regular production nicking.

Figure 6 — Removing surface defects from billets after annealing, using high speed deseaming or scarfing torches.

Figure 7 — Manual nicking still maintains its position in some mills. This operator nicks one side of the billet along chalk lines.

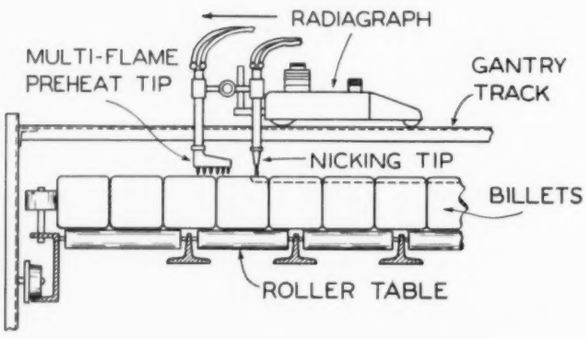
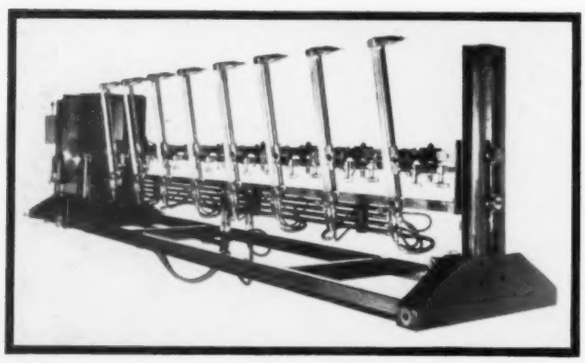


Figure 8 — Set-up for machine torch nicking of billets on one side only. Preheat torch enables uninterrupted travel across rounded edges. Gantry track is moved from one nicking position to the next.

▲

Figure 9 — For one-side nicking, the eight torches on this machine move vertically upward, making all nicks on a 22 foot billet in two passes.



single torch; where greater speed of output is required two torches may be used, each cutting a full row of nicks.

For the larger sizes of billets, common practice is to handle them one at a time, making nicks singly or in multiple. At one large steel mill where nicking on one face only is practiced, the eight-torch machine shown in Figure 9 is used. Torch movement on this machine is vertical, nicking from the bottom upward. Billets of 22 ft 2 in. length are brought in on motor-driven rolls and lined up in position for the first pass of the machine. Nicking is accomplished in two passes, each covering half the length of the billet, marking it off to a total of seventeen segments. A hydraulic ram straightens out any curvature in the billet during the nicking operation, so that the torches need not be individually adjusted to conform to its shape.

A schematic diagram of the layout at this plant is shown in Figure 10. From the nicking machine the billets are conveyed by motor driven rolls to a transverse conveyor bed where two radiagraphs crop the ends to exact length. After water spraying the billets are again picked up by gear driven rolls and carried to the breaking machine. These rolls are indexed to move the billet forward 14 inches at a time, bringing each nick successively into position for breaking. A converted gag press is used for this operation. The broken sections or shell blanks are then carried by conveyor to a ram, which lines them up in rows of six. An air hoist then stacks them vertically in boxes for conveyance to the furnace room.

While the production requirements at this plant and at several others permit nicking to be done on one face only, positive assurance of obtaining square fractures usually requires two nicks on opposite faces of the billet. A number of different types of machines have been designed for this purpose, usually with two torches mounted as a unit. It is entirely feasible to employ several such units simultaneously, or as many as the

straightness of the billets will allow. Up to the present, however, there has been little need to multiply the output in this manner, since the rapid production of the two-torch machines usually sets as fast a pace as the handling, breaking or furnace facilities can meet.

Figure 11 shows a set-up in which the billet remains stationary while the nicking head, mounted on a carriage, moves on overhead tracks from one nicking position to the next. Torch travel is upward, with the tips set at a 45 degree angle to prevent slag from blowing back into the flame orifices. Cutting speeds range from 22 to 28 inches per minute, producing nicks of approximately ¼ inch depth and about the same width. The billets are brought to the gravity roller bed by a hand operated magnetic hoist, and after nicking they are moved further along the rollers to the breaking machine. From this point the broken shell blanks move on gravity rollers to the furnace or to storage.

While this method produced excellent fractures, experiments at this plant showed that satisfactory results could be obtained by nicking only one face of the billet. The production data given in Table I were observed when the machine was employed on double nicking.

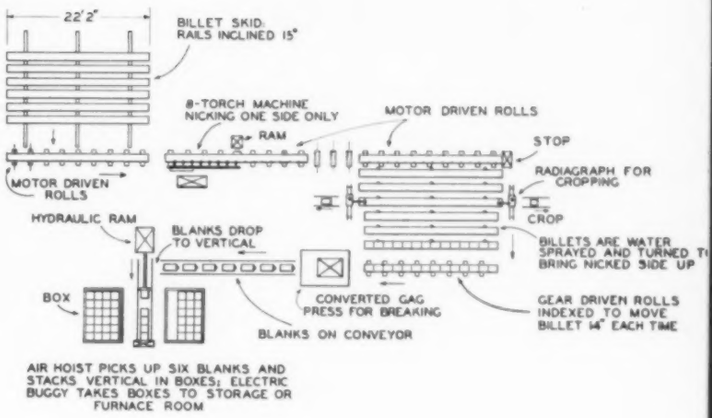

22'2"
BILLET SKID RAILS INCLINED 15°
8-TORCH MACHINE NICKING ONE SIDE ONLY
RAM
MOTOR DRIVEN ROLLS
STOP
RADIAGRAPH FOR CROPPING
CROP
MOTOR DRIVEN ROLLS
HYDRAULIC RAM
BLANKS DROP TO VERTICAL
BILLETS ARE WATER SPRAYED AND TURNED TO BRING NICKED SIDE UP
BOX
CONVERTED GAG PRESS FOR BREAKING
GEAR DRIVEN ROLLS INDEXED TO MOVE BILLET 14" EACH TIME
BLANKS ON CONVEYOR
AIR HOIST PICKS UP SIX BLANKS AND STACKS VERTICAL IN BOXES; ELECTRIC BUGGY TAKES BOXES TO STORAGE OR FURNACE ROOM

Figure 10 — Scheme of plant layout employing machine shown in Figure 9. Motorized rolls and conveyors keep billets moving in a constant stream.

TABLE I

MACHINE OXYACETYLENE NICKING

Production data — 8¼ in. x 8¼ in. square billets

Analysis	approx. .60-.65 carbon
Size — billet, in.	8¼ x 8¼ x 100
Size — shell stock blank, in.	8¼ x 8¼ x 20
Billets nicked	500 per 16 hours
Blanks produced	2500 per 16 hours
Nicks (both sides simultaneously)	2000 double nicks per 16 hours
Nick depth, in.	approx. ¼
Nicking speed	approx. 22 in. per minute
Oxygen consumption — total	1980 cu ft per 16 hours
Oxygen consumption, approx.	1.0 cu ft per double nick
Total length of both nicks, in.	16½

A machine of a different design is employed at another mill engaged in similar work. As shown in Figure 12, this machine stands stationary while the billet itself is moved forward by increments for each nicking operation. Still another type of machine, likewise stationary except for vertical torch motion, is illustrated in Figure 13. This machine is mounted above a bed of motorized rolls, and has a handwheel adjustment to bring the torches into exact position, to compensate for lack of precision in stopping the rolls. The locations for the nicks may be marked on the billet or may be determined by use of a mechanized stop and index bar arrangement. When both sides are nicked, it is advisable to employ two operators, one on each side. The torches

Figure 11 — This machine nicks two opposite faces of billet simultaneously, moving along its track from one indexed position to another. Such machines may have four or more torches for multiple nicking.

Figure 12 — Here the billet nicking head is fixed and the billets pass beneath and between the torches, stopping at indexed points. Torch tips point downward 45 degrees to avoid slag blowing back.

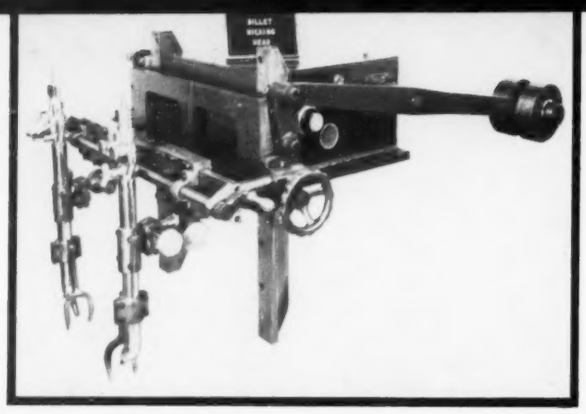


Figure 13 — This recently designed machine operates in fixed position, and is fully adjustable as to torch position. Billets pass beneath the motor box.

are dropped to preheating position at the bottom of the billet and after about five seconds preheating time the cutting oxygen stream is released. Nicking proceeds at an upward speed of 20 to 30 inches per minute.

BREAKING

Oxyacetylene nicked billets may be broken by drop hammer, bulldozers, joggle or punch presses, hydraulic presses, shears fitted with breaking heads and saddles, or any method applying sufficient pressure, or combined shock and pressure. The energy required to produce the break is dependent on the leverage or spread of supports, on the firmness of the support and the amount of residual stress produced by the heating and nicking of the material. In some instances breaking equipment is located in the nicking-room or area adjacent to the nicking operation and frequently such conditions, due to the short interval between these operations, require that the billet be quenched at the nicking areas to insure a cold break and clean fractures. Or the breaking may be deferred and be located remotely from the nicking operation, in which case sufficient time may elapse to provide ample natural cooling.

When breaking, ample power must be employed to obtain a clean fracture and to insure production speed. As an example, at one point a 200 ton crank type electric gag press is used for 75 mm blanks; a 250 ton crank type electric gag press for 90 mm blanks; a 350-400 ton hydraulic press for 105 mm, and a 1200 ton rebuilt electric gang punch press for the 155 mm blanks.

Nicking of round billets and bars comprehends essentially the same technique employed for square billets. Nicks may be made on one side (segment), opposite sides (segments), or about the complete circumference. This operation may be performed with a hand torch or automatically with machine torches using suitable gauges,

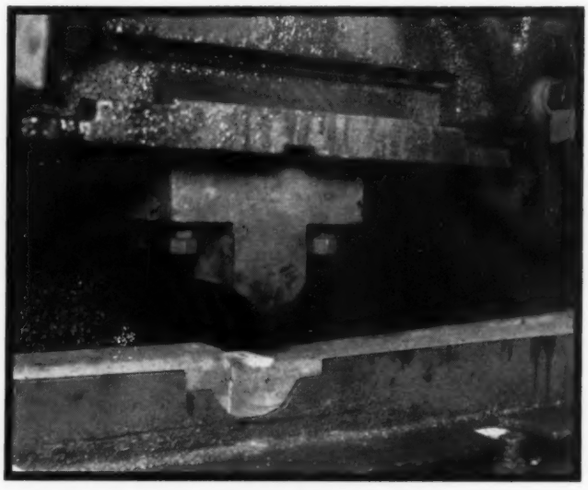


Figure 14 — These shears are fitted with a breaking head and saddle. Bulldozers, drop hammers and presses are also being used for breaking up nicked billets.

stops or guides to align the nicks. Relative motion between torch and billet in machine nicking is usually, though not always, provided by rotating the round billet slowly before the torch. In the set-up shown in Figure 1, used during the first world war, the supporting rolls were turned by hand. Motor driven rolls are more satisfactory, of course, as in the diagram of two-torch nicking, Figure 15.

The method of nicking round billets illustrated in Figure 16 differs from the foregoing method in that the

TABLE II
MACHINE GAS CUTTING DATA — GOTHIC SQUARES — SHELL STOCK BLANKS

Billet size, in	3¼—3½ sqs	3¾ sqs	4⅝ sqs
Number of cuts in 8 hours	650	620	350
Number of cuts in 1 hour	81	78	44
Average speed, in. per minute	4.7	4.8	3.4
Actual cutting speed, in. per minute	8¼—8½	8—8¼	7½—8
Actual cutting time in 8 hours	4 hr—25 min	5 hr	3 hr—40 min
Oxygen consumption, cu ft per 100 blanks	160	220	360

Oxygen consumption for manual preheating not included. For each 100 blanks of any size there will be an additional consumption of 25 cu ft of oxygen.

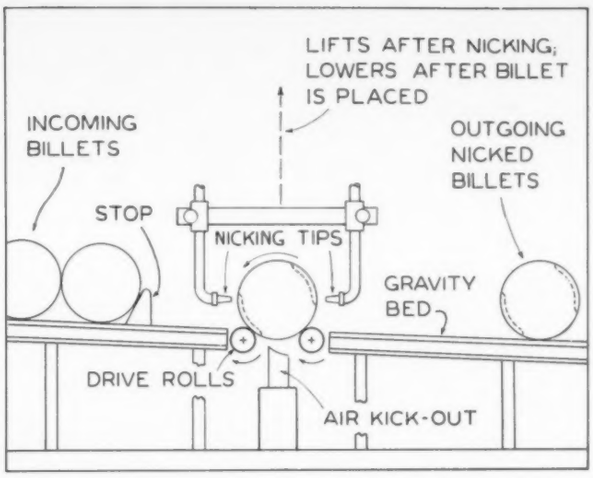


Figure 15 — Round billets may be nicked several inches on opposite sides as shown, or around the full circumference.

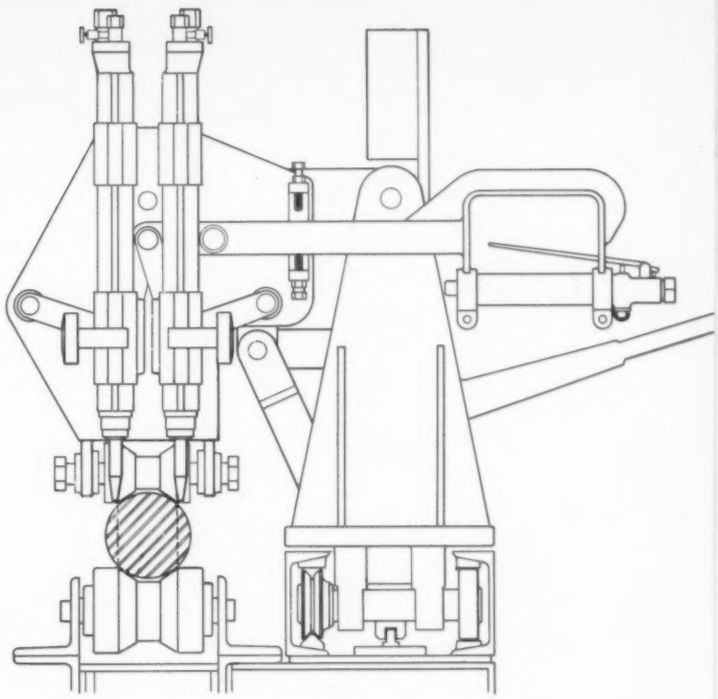


Figure 16 — This new machine makes two vertical cuts part-way through a round bar. Torches are moved by a linkage system to follow the curved surface.

two torches make opposite vertical cuts part way through the round bar. A link motion device carries the torches upward and inward simultaneously, following the curvature of the billet, which does not rotate during cutting. As in the nicking of square billets, the round bar is carried forward from one nicking position to the next on rolls, these being special centering rolls in this case. This method of partial cutting is considerably more rapid than the other procedures described and illustrated heretofore, but it is most suitable to round bars of small and medium diameter.

Whether nicking and breaking, or completely cutting through the billet, is to be employed is a decision resting largely with the manufacturer. As already stated, complete cutting necessitates the use of etching to comply with the specification requirement that each shell blank be inspected for defects. However, other factors such as the size of the billet, inadequate breaking facilities, and costs, may influence a decision in favor of complete severance by the cutting torch. The most economical procedure on square billets is that illustrated in Figure 17, in that uninterrupted travel over any length row of billets is possible.

This procedure requires only one setting of the torch, and continuous cutting is limited only by the area of space available for the work. Cranes place the billets in bales onto the work table where they are arranged in close formation. Crooked billets are turned to bring the bent sides horizontal, either up or down, and each billet is pushed flush against a front stop. The radiagraph track sets upon a gantry frame spanning the billet table. After cutting has started at a marked point on the first billet, the operator preheats the rounded corner of the second billet with a hand torch, and so on across the row.

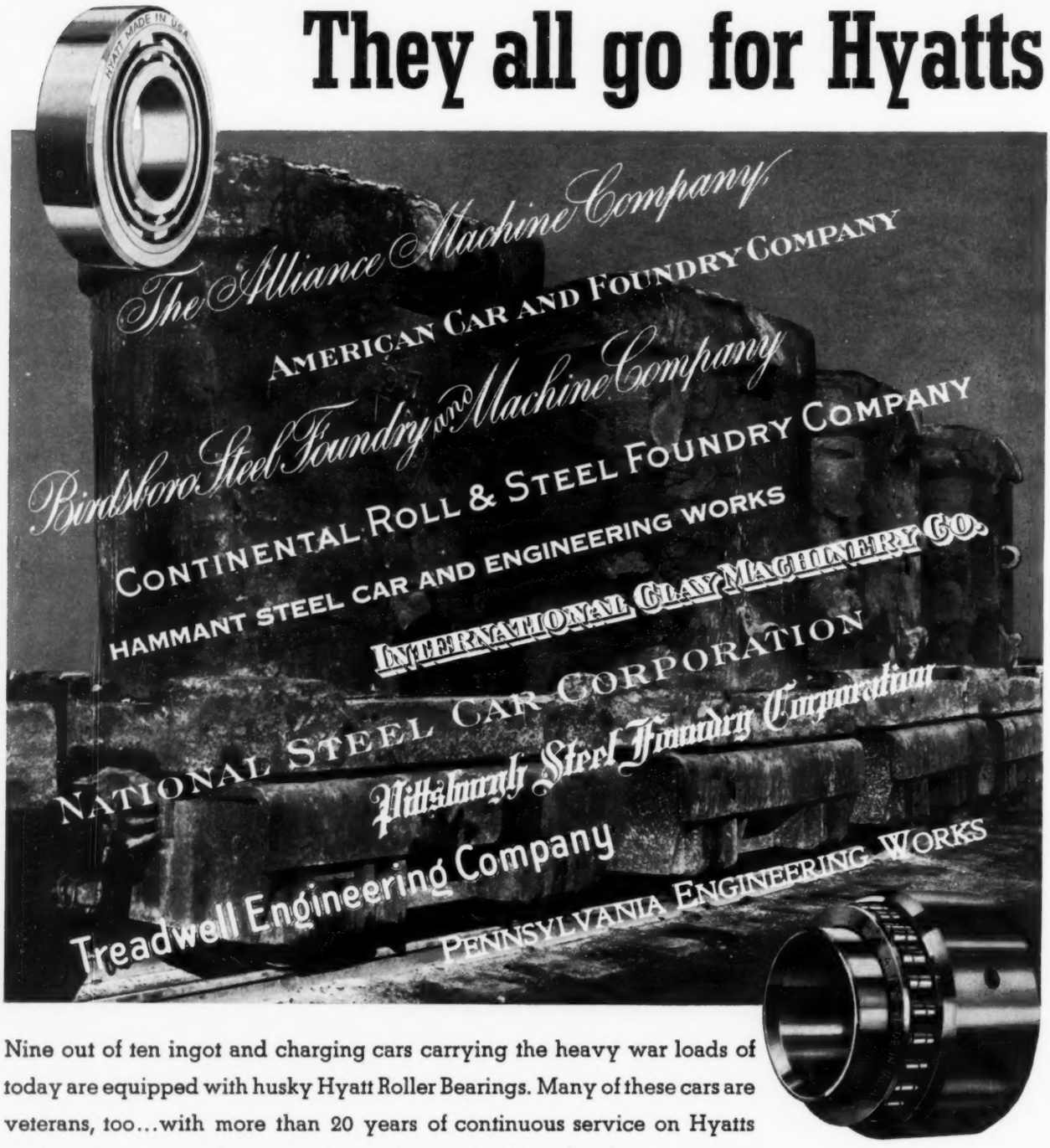
Upon completion of the full length of cut the blanks are lifted out, and the remaining lengths of billets moved up against the front stop. This procedure is followed at this plant, where the gantry is in fixed position. With a movable gantry this repeated re-alignment of billets is avoided, and the cutting of each row need not wait upon removal of previously cut blanks.

The data in Table II on machine gas cutting were observed at a munitions plant employing the above procedure for making Gothic square shell stock blanks.

It should be pointed out in conclusion that each of the various nicking machines and procedures described has been developed to accommodate most efficiently the conditions of manufacture encountered and desired in each plant. Since billet nicking is almost exclusively a wartime activity, the majority of plants now engaged in it have adapted new equipment for oxyacetylene nicking to their permanent facilities for handling and breaking. It must certainly be expected that present-day procedures will be modified as greater experience is gained, but sufficient knowledge is already at hand to establish the foregoing methods as basically the speediest and most economical ways for producing the millions of shells and bombs needed by our armed forces.

Figure 17 — For complete cutting of small billets the cutting machine on gantry employed here is most efficient. Hand torch is used to preheat rounded corner of each billet.

They all go for Hyatts


HYATT MADE IN U.S.A.
The Alliance Machine Company
American Car and Foundry Company
Birdsboro Steel Foundry and Machine Company
Continental Roll & Steel Foundry Company
Hammant Steel Car and Engineering Works
International Clay Machinery Co.
National Steel Car Corporation
Pittsburgh Steel Foundry Corporation
Treadwell Engineering Company
Pennsylvania Engineering Works

Nine out of ten ingot and charging cars carrying the heavy war loads of today are equipped with husky Hyatt Roller Bearings. Many of these cars are veterans, too...with more than 20 years of continuous service on Hyatts *without bearing replacement.* Some of the car builders listed above started using Hyatts more than thirty years ago. That Hyatts have done their job well is evidenced by the fact they are still serving...and that practically all other builders have since built with Hyatts. To keep your cars on the go, play safe and specify Hyatts for all new equipment and change-overs. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

HYATT ROLLER BEARINGS

Roll Oils AND Coolants FOR THE Cold Mill

. . . . in the cold reduction of strip, the diminishing palm oil supply can be offset by conservation of existing stocks and by the use of substitutes which have been developed . . . .

by MAURICE RESWICK

ENGINEERING DIVISION

STANDARD OIL CO. of New Jersey

NEW YORK, NEW YORK

▲ THE high speed tandem mill for cold rolling of sheets and tin plate is an accomplished fact, and a 4 or 5 stand mill in operation is a sight which stimulates our admiration of the mill builders and mill operators. To produce continuous coiled strip down to about 0.007 in. at a speed of nearly 3,000 fpm is a feat which demands the highest type of co-ordination and minute attention to the mechanical characteristics of the mill proper to variations in the steel rolled, and to rolling practice. This paper deals with only two features of rolling practice, namely, the reduction of external friction between the strip and the rolls and dissipation of the heat generated in the plastic flow of the metal.

All rolling operations involve two kinds of friction. First, the internal molecular friction of the steel in its resistance to deformation and, second, the external friction of the strip against the roll surfaces. The internal friction is one of mechanically unrestrained plastic flow, while the external surface friction, restrains the outer layers of the strip from following the middle layer at the same rate, which is compensated by slipping. As the strip becomes thinner, the effect of external or surface friction becomes more predominant, as evidenced by the fact that it requires more pressure to roll very thin sections. This is due not only to the increase in hardness from cold working in the successive passes, but also to the fact that most of the deformation takes place at the outer surface layers.

Outside of metallurgical control and annealing, nothing can be done to reduce the internal molecular friction in the metal itself but the external friction can and must be minimized to the lowest possible value by lubrication. The effect of lubrication at slow cold rolling is illustrated in Figure 1, taken from the report of W. Trinks and J. H. Hitchcock presented to the American Society of Mechanical Engineers in 1930. From this figure it is seen that as the pass reduction becomes greater, the effect of the lubricant becomes more pronounced, which is directly reflected in power consumption.

As the cold rolling speed is increased the power expended as external frictional heat becomes greater due to the more rapid rate of deformation of the metal, and the lubrication factor is more important. Without effective lubrication cold rolling of tinplate stock would be an impossibility.

The type of lubricant used for cold rolling of strip is also of importance. For example, tests have shown that for the same degree of work-hardness, progressively greater reductions may be taken with fluid lubricants in the following order: dry, water, kerosene, compounded mineral oil, and palm oil. The surface finish or luster, however, is in the reverse order.

It is conceivable that the lubrication effect could be extended to the point where it will interfere with the "bite" of the bar or strip between the rolls, which may cause slipping and the production of corrugated sheets, but this can happen only on a hand operated 2-high mill. On reversing 4-high mills and on modern tandem mills the tension reels more than neutralize this tendency.

The question may be asked how any lubricating film can exist between the strip and the rolls under separating pressures in the order of 5 to 6 million pounds. The only answer is that correct lubrication does help to produce smooth surfaces at high speeds, and that the absence of lubrication results in torn strip, poor surface finish, and lower roll life. As good an explanation as any is that some of the lubricant penetrates or becomes absorbed in the interstices of the metal during preced-

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 22-24, 1942

TABLE I
THERMAL PROPERTIES OF OIL AND WATER

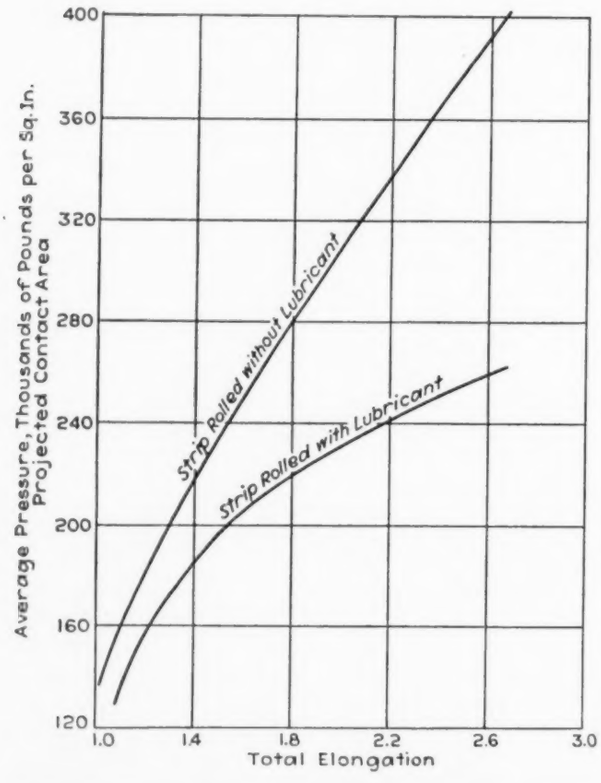
	Lubricating oil	Water	Ratio, water to oil
Specific heat	0.5	1.0	2
Heat conductivity	.000355	.00131	3.7
Boiling point, F	Over 600	212	.3
Latent heat of vaporization, Btu per lb	90	970	10.8

ing passes and becomes active in an hydraulic sense under the pressure of the rolls.

This suggests that the lubricant used must have high adsorption properties or low surface tension to adhere or wet the steel even in the presence of water, and this is substantiated by actual experience. Vegetable and animal oils possess these properties, and when used in combination with mineral oils, the advantages of both are combined in the compounded roll oil.

Conventional lubrication theories adopted for sliding surfaces and bearings do not hold good under the condition of high pressures in cold rolling. In bearing lubrication the viscosity of the oil is a prime factor, and the heavier its body the greater is its film strength or its resistance to adhere between the sliding surfaces.

Figure 1 — Curves showing the effect of lubricant upon the rolling pressure in cold reduction of steel strip.



Correlated research work done by several laboratories demonstrated the fact that the viscosity of oils increases under high pressures. For example, at about 15,000 psi and at 100 F, the viscosity of a mineral oil is ten times greater than at atmospheric pressure and at the same temperature. Animal and vegetable oils also increase in viscosity with pressure, but only about one-fourth as much. Doubtless this effect of increase in viscosity of oils under pressure may be considered as a factor in the performance of lubricants in cold rolling.

FUNCTION OF LUBRICANTS AND COOLANTS

The requirements of lubrication and cooling are localized in the same place at the area of contact between the strip and the rolls. For lubrication we need an oil having good film strength, but to carry away the heat we require a fluid medium having the highest possible rate of heat absorption and dissipation, which is best met by water. This is seen from Table I, showing the thermal properties of suitable lubricating oils and water.

As compared with oil, the specific heat of water is double, the heat conductivity almost four times greater, the boiling point less than one-third, and its latent heat is nearly eleven times as much. Using simple arithmetic, this means that for the same flow and evaporation, the cooling properties of water are approximately 2 x 4 x 11 =88 times greater than for oil.

Two principal methods of application are in vogue. By one method the roll oil is applied directly while a stream of water is applied independently. By the other method the lubricant and the water are mixed together and the "solution" in copious quantities is re-circulated. Both systems have their adherents among cold mill operators, and it is outside the scope of this paper to discuss this controversial subject, since good strip is produced by both methods.

The function of the coolant constituent of the "solution" or of the water, is obviously to remove the generated heat in a controlled manner and also to regulate the contour of the rolls under thermal expansion, and thus assure equal distribution of rolling pressure and evenness of gauge.

The lubricating constituent in the "solution" or roll oil has a direct effect on power consumption, prevents pick-ups on the rolls, imparts a better finish, permits rolling at higher speeds, and the portion of the lubricant carried over acts as a rust preventive until the next process or fabrication operation.

An important requirement of the type of lubricant

used is that it may be readily removed in subsequent cleaning operations, particularly when using electrolytic cleaning lines, where speed is a factor and low cost of cleaning materials is mandatory to produce a chemically clean strip for tinning.

Table II shows the types of roll oils and coolants in current use on representative mills, which may be classed as follows:

1. Straight mineral oils in viscosities from 50 to 200 SSU at 100 F.
2. Mineral oil compounded with animal and vegetable fats.
3. Soluble oil emulsions with water.
4. Soluble oil and palm oil emulsions.
5. Straight palm oil, heated.

The particular system used depends on the original design of the equipment, type of work done, and in a very large measure on the preferences of the mill operators.

MINERAL AND COMPOUNDED ROLL OILS

For rolling strip of heavy gauge such as auto body stock and break-down stock for tinplate, at relatively low speeds, straight mineral oil or compounded with animal and vegetable oils, answers all requirements. The pressures and external friction between the strip and the rolls are also relatively low, mainly because the metal is softer and deformation is taking place largely in the middle layers between the surface of the steel.

On the Steckel type mill, with work rolls of a small size and not power driven, the total pressures are smaller than on mills whose work rolls are of a larger size and power driven. Hence, in most instances, straight mineral oils and compounded oils are satisfactory for ferrous and non-ferrous strip.

ROLL EMULSIONS

When the first single stand reversing 4-high cold mills were introduced it was logical that a closed circulating system of a soluble oil emulsion would be used as the lubricant and coolant. Most mills of this type are now operated in this manner, the emulsion or "solution" consisting of 4 to 5 per cent of soluble oil in water. It was observed in early experiments that raising the soluble oil content to about 16 per cent resulted in a better finish. The exact proportion depends on the degree of finish desired.

In rolling strip other than tinplate stock on tandem mills, a soluble oil emulsion with water is often used on the break-down passes, and straight or compounded mineral oil on the finishing passes. The theory is to permit a maximum reduction before the material develops a high degree of work hardness and then to take a lighter finish pass to obtain a fine surface finish.

With the advent of the tandem cold roll mills, further enrichment of the solution in lubricating properties was thought necessary, and the addition of palm oil apparently answered the purpose. Many tandem mills

TABLE II
CURRENT PRACTICE IN ROLL OIL APPLICATION

Type of mill	Number of stands	Material rolled	Coolant system	Roll oil used	Application	Recovery
4-high tandem	4 & 5	Tin plate	Yes	Soluble oil plus palm oil	Circulation	....
4-high tandem	4 & 5	Tin plate	No	Straight palm oil, heated	Spray	Yes
4-high tandem	2, 3, 4	Heavy strip	Yes	Soluble oil	Circulation	....
4-high tandem	2, 3, 4	Strip and sheets	No	Straight oil, 100/200 SSU	Drip	No
2-high tandem	2 & 3	Strip and sheets	No	Straight or compounded mineral oil	Drip	No
2-high temper pass	1	Strip and sheets	No	None	.....	....
4-high reversing	1	Tin plate	Yes	Soluble oil	Circulation	....
4-high Steckel	1	Strip steel and non-ferrous	Yes	Straight oil, 150/175 SSU	Circulation	....
2-high, 4-high reversing non-reversing and tandem	1–5	Aluminum	No	150/200 SSU, compounded oil at slow speeds	Drip	No
2-high, 4-high reversing non-reversing and tandem	1–5	Aluminum	Yes	50/100 SSU, compounded oil at high speeds	Circulation	....
2-high, 4-high reversing non-reversing and tandem	11	Hot aluminum billets	Yes	Soluble oil	Circulation	....
2-high, 4-high reversing non-reversing and tandem	1 & 2	Brass and copper	No	150/200 SSU, compounded oil	Drip	No

are now operated on solutions consisting of an emulsion of water with 2 to 6 per cent of a mixture of soluble oil and palm oil, the function of the soluble oil being mainly to act as a dispersing agent for the palm oil. Proprietary products of an undisclosed composition are also in use experimentally as emulsions with water, the aim being to provide a maximum of cooling and adequate lubrication.

PALM OIL

Palm oil is a native of Sumatra and West Africa. It is produced from the pulp or fleshy layers of the fruit of the palm, either by extraction or by disintegration with the oil floating up to the top. Abundant supplies of palm oil exist and it has been relatively cheap so long as imports could be continued, although a rather heavy processing tax of 3 cents per pound is placed on it for all purposes other than those of the tinplate industry.

Palm oil was adopted for cold rolling probably on account of its availability, since its use in tin pots as a flux and anti-oxidant has been standard practice in tinning operations. Curtailment of imports, which formerly amounted to about 21,000 net tons per year for the steel industry alone, necessitates conservation of present stocks and the development of a satisfactory replacement for palm oil.

Crude palm oil varies in its chemical and physical properties, but the following data may be used as average values:

Melting point	96 F
Flash point	430 F
Fire point	500 F
Viscosity at 210 F, SSU	53
Iodine value	54
Saponification value	197
Saturated acids	45%
Unsaturated acids	51%
Unsaponifiable	0.1%

In chemical composition palm oil is essentially a mixture of several component fatty acids and their glycerides. The principal ingredients are palmitin and olein plus small amounts of other glycerides, and a representative percentage composition of the fatty acids is as follows:

	Per cent
Myristic acid	1.5
Palmitic acid	37.0
Stearic acid	5.0
Oleic acid	47.5
Linoleic acid	9.0

The free fatty acid varies within wide limits, 50 per cent being present in some samples. No. 1 palm oil, the best grade, is said to contain from 8 to 12 per cent free fatty acid, No. 2 grade 15 to 20 per cent and No. 3 grade up to 40 or 50 per cent.

The significance of this chemical analysis is that it shows palm oil to be a complicated mixture of many fats and acids, and that it contains a high percentage of unsaturated acids, which accounts for its relative unstability and its susceptibility to deterioration.

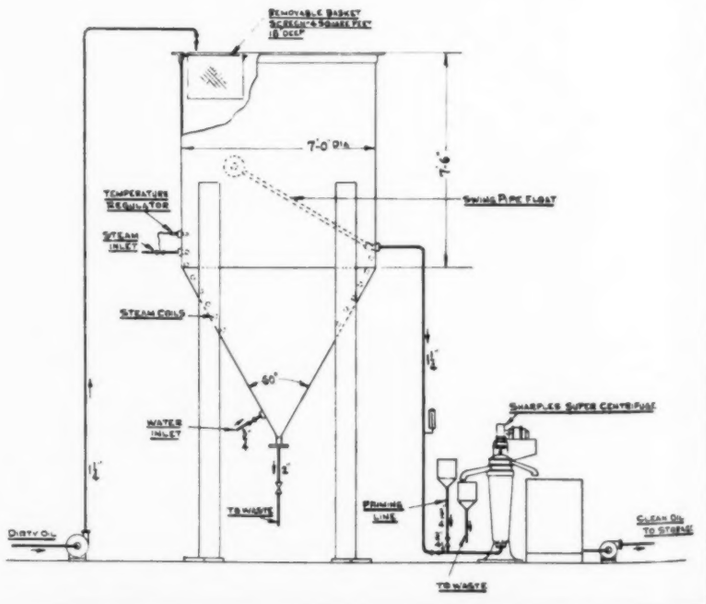
As it has been indisputably demonstrated that palm oil is a good lubricant for rolling, we are free to make conjectures as to why it is so. Chemists attribute it to the content of palmitic acid and the presence of high molecular weight or long chain carbon molecules. Palm oil is reputed to form a lubricating film which does not break down at high temperatures, and doubtless high temperatures exist at the line of contact between the strip and the rolls, in the area of maximum metal deformation and frictional drag against the rolls. In the early days of the single stand 4-high reversing mill, temperatures of 500 to 600 F were recorded at speeds of 650 to 1000 fpm and on the modern faster tandem mills higher temperatures may be expected.

PALM OIL APPLICATIONS

Palm oil is usually received in steel tierces, and dumped into a sump tank after the drum has been warmed sufficiently to change it from a semi-solid or viscous state to a liquid. In common with other solid and semi-solid fats, palm oil changes from a solid to a liquid quickly at a temperature of about 96 F. The palm oil is kept heated in the tank at an average temperature of 160 F and the liquid is pumped to the mill stands, where it is applied by spray to the top and bottom back-up rolls. As it impinges on the relatively cool roll surface, the liquid palm oil loses its fluidity, becoming more viscous and the copious flow of cold water assists in this change without washing it off, so long as the pressure of the stream is not high enough to shear it off.

Even when applied to the roll surface through only two outlet nozzles, or to the strip, the entire surface of the work rolls gradually becomes coated evenly with palm oil, partially emulsified with water, so that lubrication over the entire width of the strip is assured. Just what happens at the contact area of the work rolls with

Figure 2 — General arrangement of one system developed for the reclamation of palm oil.



the strip is problematical. The temperature of the strip is sufficiently high to change the water into a cloud of steam, and to liquefy the palm oil to a thin film and a portion of the palm oil is carried over to the next pass either as a surface film or by absorption in the grain of the steel.

For rolling sheet stock or for break-down either on single stand or tandem mills, the roll oil problem is not acute. The external friction of the strip against the rolls is relatively small so long as the finished gauge is over 16. Straight mineral oil of a light viscosity meets all requirements of a roll oil.

In rolling to tinplate gauge however, more lubrication is necessary, and resort is made to emulsions of water with soluble oil, water with soluble oil or other emulsifying agent plus palm oil, or palm oil straight.

RECOVERY OF PALM OIL

The recovery of palm oil for re-use on the mills is now more important than ever, and fits in with the national program of conservation of essential materials.

The quantity of palm oil used per ton of strip is a controversial subject, and depends on local conditions, such as mill design, whether 4 or 5 stands, gauge, surface finish, method of application, etc. Some mills report 6 pounds per net ton and even lower, but about 8 to 9 pounds per ton of strip is common practice, distributed as follows: 1 lb per ton applied after pickling as a rust inhibitor and also as the lubricant on the first stand, and the remainder distributed over the mill stands. The largest quantity is used on stands 3 and 4 in 5-stand mills, and on stand 3 in 4-stand mills. It is only on special occasions when palm oil is applied to the finishing stand.

Palm oil being of vegetable origin and of variable quality, undergoes minor chemical changes in composition while it passes through the rolling operation. It partially disintegrates, oxidizes, forms metallic soaps, and picks up considerable mill dirt and metallic particles as evidenced by the change in color from yellow to dark brown. In reconditioning of palm oil for re-use, all emulsified water and impurities must be removed.

Methods of salvaging and reconditioning of palm oil gathered at the mill pit vary from simple to the most elaborate systems. The principle involved is one of removal of contaminants by heat, settling, filtration, and centrifuging. The system may be home-made or purchased from manufacturers who specialize in such equipment.

An elaborate system for the reconditioning of palm oil, involving dehydration, re-refining, and filtration, was described in a paper presented before the Cleveland and Youngstown Sections of this Association in February, 1942, by R. P. Dunmire, of the Buckeye Laboratories, Inc.

A simplified diagrammatic layout of a system for the clarification of palm oil as sponsored by one manufacturer is shown in Figure 2. The palm oil sludge from the trench or sump under the cold mill is pumped to a settling tank through a $\frac{1}{8}$ in. mesh screen. The charge of sludge in this tank, which may contain 40 to 60 per cent moisture, is heated to 250 to 260 F, the tank being totally enclosed to carry the corresponding pressure of the water vapor.

After the sludge has been held at this temperature for 10 to 12 hours, the major portion of the water and dirt will have settled out and are discarded as waste from the bottom of the cone.

The palm oil at 250 F is drawn off through the floating suction arm directly to a centrifuge in which it is purified at a throughput rate of 100 to 200 gallons per hour, depending upon the condition of the oil and the degree of purification required. The tanks are installed in duplicate to permit the equivalent of continuous operation.

The amount of palm oil recovered varies between 50 and 72 per cent of that used on the cold mill. It has been the practice of some mills to sell the purified palm oil to soap manufacturers, but the most recent trend is to re-use it on the mill with admixture of fresh palm oil. Operating costs are said to average between 0.8 and 1.0 cents per pound of reclaimed palm oil, including all fixed charges.

PALM OIL REPLACEMENTS

Heretofore mill operators were not over-enthusiastic about palm oil replacement, so long as they felt that an abundant supply of palm oil is available at low prices. Under existing war conditions, with the disappearance of domestic supplies in sight, everybody from the management to the mill operators is concerned about the situation, and is on the look-out for a replacement which may eventually prove better even than palm oil.

Mills using the closed circulating system for cooling and lubrication, involving not more than 5 per cent palm oil in the "solution," should not have a difficult problem in finding a replacement among domestically available emulsifiable fats or proprietary chemical compounds. But mills using the dual system of water for cooling and palm oil for lubrication are facing a real problem. Not the least phase of this problem is the reluctance of mill operators to any change in procedure and application from the established practice. The line of least resistance is obviously a product which in its physical properties resembles that of palm oil.

A product of this description has recently undergone a series of severe tests in the Pittsburgh district on a cold roll tandem mill with promising results as an effective lubricant to replace palm oil. From the standpoint of economy, it is of interest to note that the usual tax of 4 cents per gallon, or approximately $\frac{1}{2}$ cent per pound which applies to fluid lubricants, does not apply to this palm oil replacement, since at 77 F it is of stiff grease-like consistency, but reverts to a fluid when heated to the temperature at which palm oil is normally used. This means a saving of approximately 4 cents per ton of strip, on the assumption that 8 pounds of lubricant is used per net ton. From the standpoint of availability, it is to be noted that all ingredients used in the manufacture of this palm oil replacement are of domestic origin, with no existing limitations on supplies.

Recovery of palm oil replacements of the type mentioned, which approaches palm oil in its physical properties, is simpler than for 100 per cent palm oil. Being a compounded product, it does not vary in quality, and the ingredients may be chosen so that they will not undergo chemical changes in the mill to the same extent

as the natural product. Essentially, heating is all that is required to settle out the water and coarse foreign particles, and centrifuging, if desired as a refinement, to remove the finer particles of mill dirt. The clarified product is then ready for re-use on the mill.

I wish to acknowledge my indebtedness to the many friends in rolling mill industry for their assistance in the preparation of this paper, especially for the co-operation extended in carrying out the necessary mill tests at a time when maximum production must be maintained.

DISCUSSION

PRESENTED BY

C. E. PRITCHARD, Lubrication Engineer, Republic Steel Corporation, Cleveland, Ohio

R. W. KINGERLEY, Development Section, Chemical Division, E. I. du Pont de Nemours and Company, Cleveland, Ohio

MAURICE RESWICK, Engineering Division, Standard Oil Company of New Jersey, New York, New York

ALEX D. BRODIE, Superintendent 93 In. Cold Strip Mill and Galvanizing Department, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

C. E. S. EDDIE, Lubrication Engineer, Great Lakes Steel Corporation, Ecorse, Michigan

C. E. PRITCHARD: The installation of higher speed cold rolling mills coupled with the inability to insure availability of so-called strategic materials has indeed presented a problem to the operator. Due to the economics involved, little or no development has been offered in the way of substitute materials in the cold rolling field until the present time.

The statement made relative to the possibility of slippage or interference with the "bite" being confined to a hand operated 2-high mill is not considered as being technically correct in that such variables as an unbalanced draft schedule, worn rolls and an overabundant supply of lubricant has resulted in similar conditions being noted in tandem mill rolling.

To secure a lubricant possessing sufficient viscosity to insure hydrodynamic lubrication under all conditions would indeed be the answer to most rolling problems. Unfortunately where such high unit pressures are encountered as in the rolling of tin plate gauges a thin film or boundary lubrication exists with a corresponding rate of metallic wear. To minimize the wear factor involved, it is apparent that a lubricant must have adequate film strength or load carrying capacity and also the ability to dissipate the heat resulting from friction of strip being reduced in cross section in its travel through the rolls.

As pointed out in Mr. Reswick's paper, the heat conductivity of lubricating oil does not meet that of water so that it is to be expected that a mixture with water or combination involving water as a coolant would provide maximum efficiency in proper control of thermal expansion of the rolls and also to aid in dissipating the heat encountered in the area of contact. This brings up the problem of adherence or adhesiveness in connection with the presence of water, the use of a vegetable oil, soluble oil or compounded mineral oil being demanded under the more severe operations while a straight mineral oil will suffice for lesser requirements.

I would like to take exception to the statement made that the conventional theories of lubrication applying to sliding surfaces and bearings do not hold good under the high pressures encountered in cold rolling practice. Although it is agreed that viscosity is not generally considered as being of extreme importance under these conditions and that an absorption of the long chain hydrocarbons probably takes place it is also believed that a thin film or boundary condition still exists. Similar conditions are known to exist under static loads or starting up periods with heavy duty machinery operations. Should this condition be found lacking it would seem an impossibility to control the rate of metallic wear which is undoubtedly accomplished in variable degrees by the different types of oils.

The differential in thought as to the proper method of application of the lubricant and coolant on the rolls and strip is probably as controversial a subject as that applied to the proper rolling practice and type of materials used, the past experience of the operator and the particular equipment on hand generally deciding such issues.

The proper control of roll contour is considered as being most essential to proper rolling practice and indirectly ties in with the economics of the mill operations. When a change in contour takes place during service it effects the power consumption and, if severe enough, the finish of the strip is also impaired. Thus, it becomes necessary for the lubricant to provide a low coefficient of friction which in turn permits a lower roll pressure to obtain a given reduction in thickness. A uniform rate of thermal conductivity is desirable to permit a better control of roll expansion and must also be provided by the lubricant and coolant.

Palm oil has been used with considerable success by the cold mill operator so that it seems logical that much thought would be given to its conservation and replacement with a suitable substitute under present world conditions.

The type of oil reclamation system used is generally dictated by the operating conditions and design of the equipment on hand, the continuous type being applicable to the soluble solution system in which the entrained contaminants are removed in passing of solution through an automatic or semi-automatically cleaned filter. The other methods being applied to operations where the oil and water are applied independently of each other are, namely, batch and combinations of both continuous and batch systems. In the batch system a volume of the oil and water emulsion is allowed to settle so that the water and insoluble contaminants may gravitate to the bottom. Application of heat and further conditioning of oil is generally demanded before re-use back on the mill.

R. W. KINGERLEY: I would like to ask Mr. Res-

wick if the new oil he is using can be cleaned from steel strip as quickly as palm oil.

MAURICE RESWICK: Yes, it can be. It is largely petroleum base and we know how to clean petroleum oil with alkalies or other chemicals or electrolytically, and it is being done successfully.

R. W. KINGERLEY: Does the oil contain saponifiable matter?

MAURICE RESWICK: It contains fats and other ingredients to carry a load, and, therefore, it is not strictly non-saponifiable, but it is not saponifiable to the same degree as palm oil.

A. D. BRODIE: I would like to make a few remarks regarding one of our most important problems, and that is a substitute for palm oil for cold reducing light gauge flat products or tin plate. In the last two years we have run many experiments in an effort to find a satisfactory substitute.

It seems that each trial on the mill came just a little closer to our aim. Our most recent trial of some 200 drums has shown the best results, and we have rolled approximately 4,000 tons of tin plate using only the substitute. We made our tests on our four-stand 54 in. cold reducing mill rolling gauges ranging from .0083 to .0123 in. and rolling our most difficult grades or specifications starting with hot bands of .075 in. gauge. I might mention that in some cases these hot rolled bands had a Rockwell of B-80. We found our strip flatness comparable with strip rolled in these same gauges in palm oil. Our motor input readings were about the same and our tension remained unchanged. Our average speed on this run was 1,400 feet per minute and our maximum speed was 1,500 feet per minute. Comparing the same product as rolled in palm oil we would say our speed was slightly reduced on the substitute oil. This reduction in speed was made due to friction scratches obtained at the slightly higher speed. We believe this condition was caused by applying the oil at too high a temperature, which caused a portion of the oil to wash off the strip between stands with the water pressure used.

A trial rolling of 75 per cent substitute oil and 25 per cent palm oil gave us no trouble whatever. In fact this test was made without any knowledge on the part of the operators. The appearance of the strip, with regard to cleanliness, both on the rolling using 100 per cent substitute oil and the run using a mixture of 75 per cent substitute, as reported by our mill inspectors, was as good or better than strip rolled entirely in palm oil. At the cleaners no trouble was encountered, although they reported that the surface had a slightly heavier film.

Of course, more experimental work will be required and more tests will have to be made before we can safely say that this oil will perform satisfactorily as a definite substitute. However, we are able to say without any hesitation that we can roll tin plate on our four-stand mill with our present equipment, using a 75 per cent solution of substitute oil.

C. E. S. EDDIE: Some months ago, this intrinsic problem of friction in rolling cold strip and its relation to lubrication, was somewhat of a bombshell to all of us involved in the cold rolling business. I am referring to the recent applied federal tax on rolling oils for tandem mill use. It would appear in retrospection that from the preliminary statements posted in this paper by Mr. Reswick, that he was implicated, or in collaboration with Uncle Sam working to give us a swell headache. So in turn we tried many ways to prove to the Bureau of Internal Revenue that they were misguided in saying that rolling oil was any form of a lubricant, — now we know why this all came about.

This paper states the facts conclusively that the rolling operation creates both internal molecular friction, and a positive external friction of the strip against the roll surfaces in which the roll oil and coolant plays the important lubrication and cleaning factor.

Due to the variations in gauge and strip widths we at Great Lakes have not found from an operation point of view whether or not the lubrication constituent of the rolling oil has any direct effect on power consumption; we do agree however that it keeps the rolls clean and free from pick-ups, metallic particles, gives better strip finish, longer roll life, and enables rolling at higher speeds.

It is important to note in view of the facts given in this paper, that the work rolls in the tandem mills are not all finished alike; the rolls in the last stand before installation are given a shot blast, or rough finish, while the other rolls are finished bright and smooth. The purpose of the shot blast is to mechanically roughen the surface, in order to prevent sticking in further processing during annealing. This also renders a better strip surface for the roll oil which stays with the strip after leaving the mill, in protecting its surface against rust in the coil storage.

In addition to the proper amount of oil supplied for the "bite" as Mr. Reswick refers to it, mention should be made that it is exceedingly important to consider the many changes in reductions, which normally vary from 35 to 75 per cent on the tandem mill itself. Heat liberation and control is an all important factor, involving the proper amounts of water supplied to the rolls for uniform cooling. This rolling feature also involves the amount of roll oil necessary in varying widths and gauges, adjustment of oil drips, and water sprays are necessarily arranged to regulate the "crown" of the roll, for accurate flat reduction across the strip. This phase is vital considering that strip widths from 90 to 24 in. demands accurate crown control for both the roll oil, and the distribution of water necessary for heat liberation.

Prior to the war we were rolling gauges from 12 down to 28, using a straight mineral oil of 100 sec at 100 F Saybolt universal viscosity, using the drip application. Under the tandem mills there is a recovery system for reclaiming and purifying this oil for reuse. We have found it necessary in rolling light gauges, to use in addition to the mineral oil, certain percentages of palm oil, or equivalent chemical compounds.

It should be noted that certain lubrication compounds have recently been developed, better known as coolant lubricants, with a base consisting of an emulsion of a blend of oils capable of being cut or diluted with water. We have not had occasion to use this application in our operation, but have some knowledge of the progress thus far made, and the personnel directing these developments have had a background of performance in major lubrication problems for a number of years. This coolant can be used as a rolling oil, as an emulsion of

palm oil, and as a compound replacing palm oil. It is also used as a drawing and cutting compound.

It is surprising to note from Mr. Reswick's paper that in the rolling of strip and sheets using 100/200 viscosity straight oil drip application, that no recovery is used; this is not strictly correct; the cost of an installation of this type can be realized in a few months of mill operation, and strange as it may seem with a recovery system, a better rolling oil is made available due to the further economic additions of small but continuous amounts of miscellaneous lubricating oils collected in the same system from the mill stands.

Recovery and purifying systems should be stressed for all lubrication applications of the steel mill industry where ever and when ever possible.

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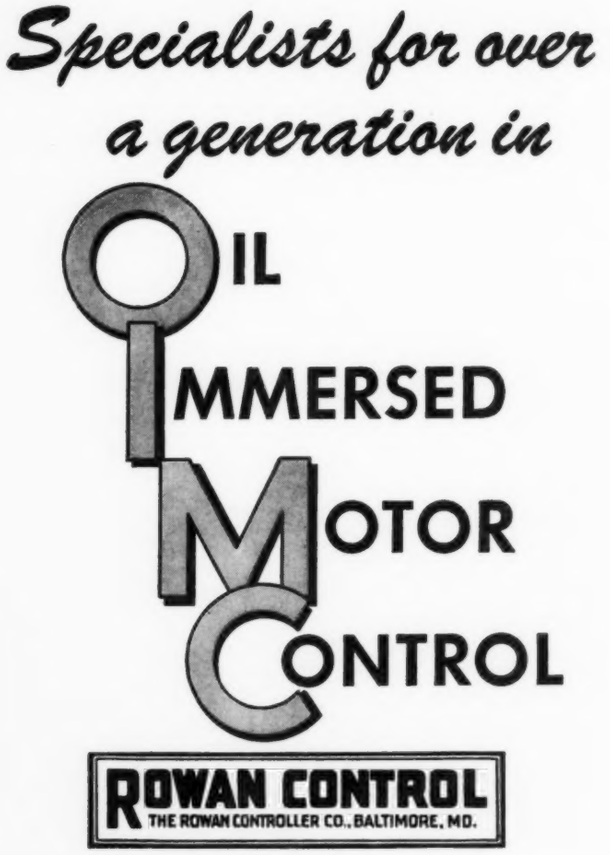

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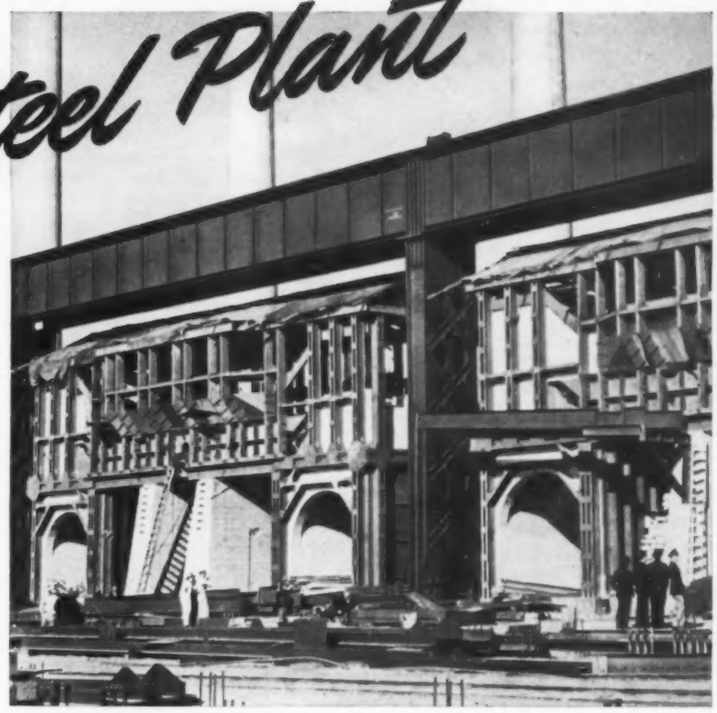

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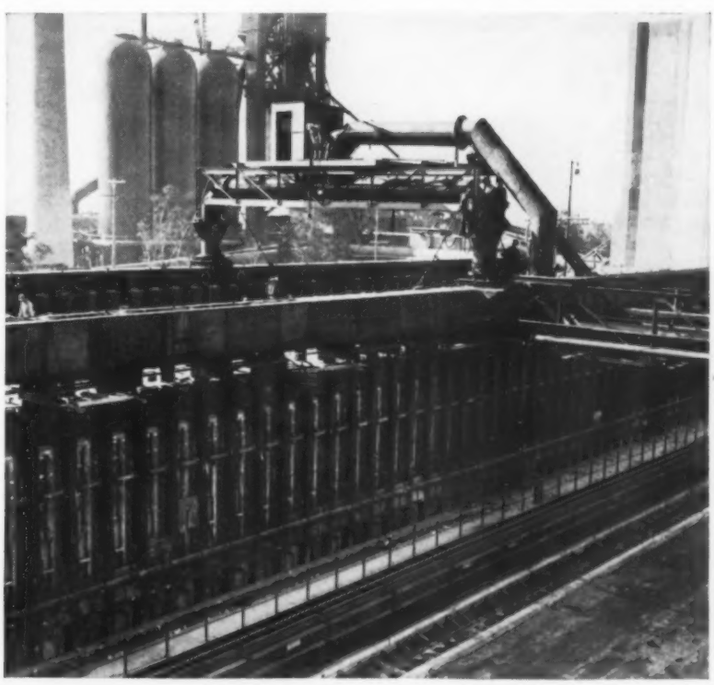

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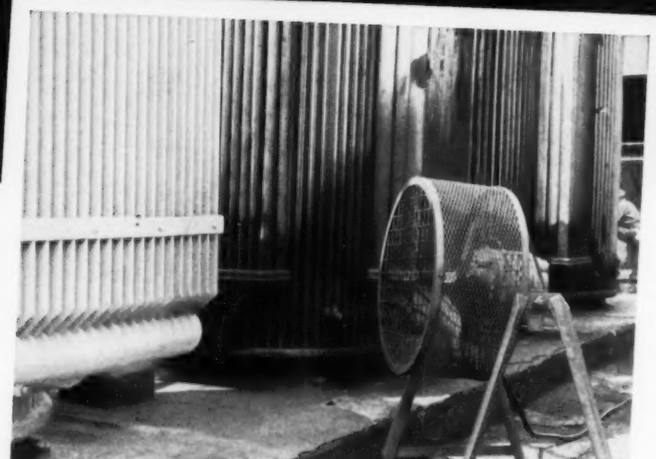

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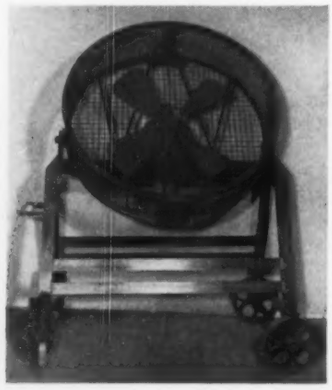

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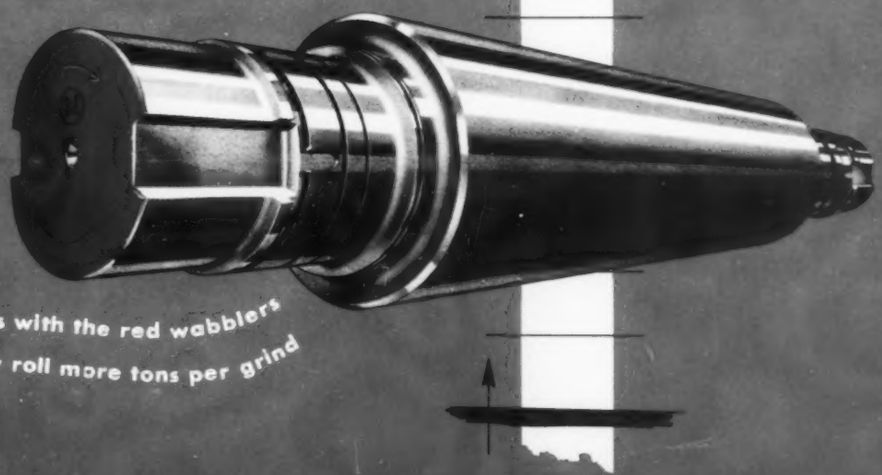
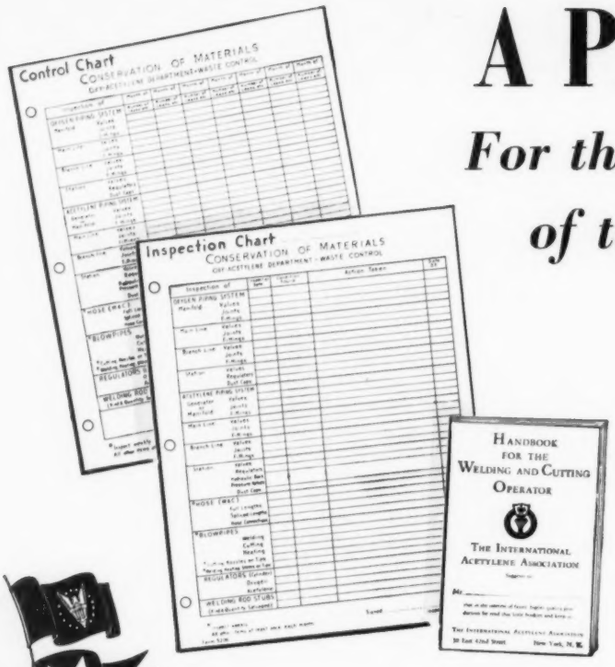


The rolls with the red wabblers they roll more tons per grind



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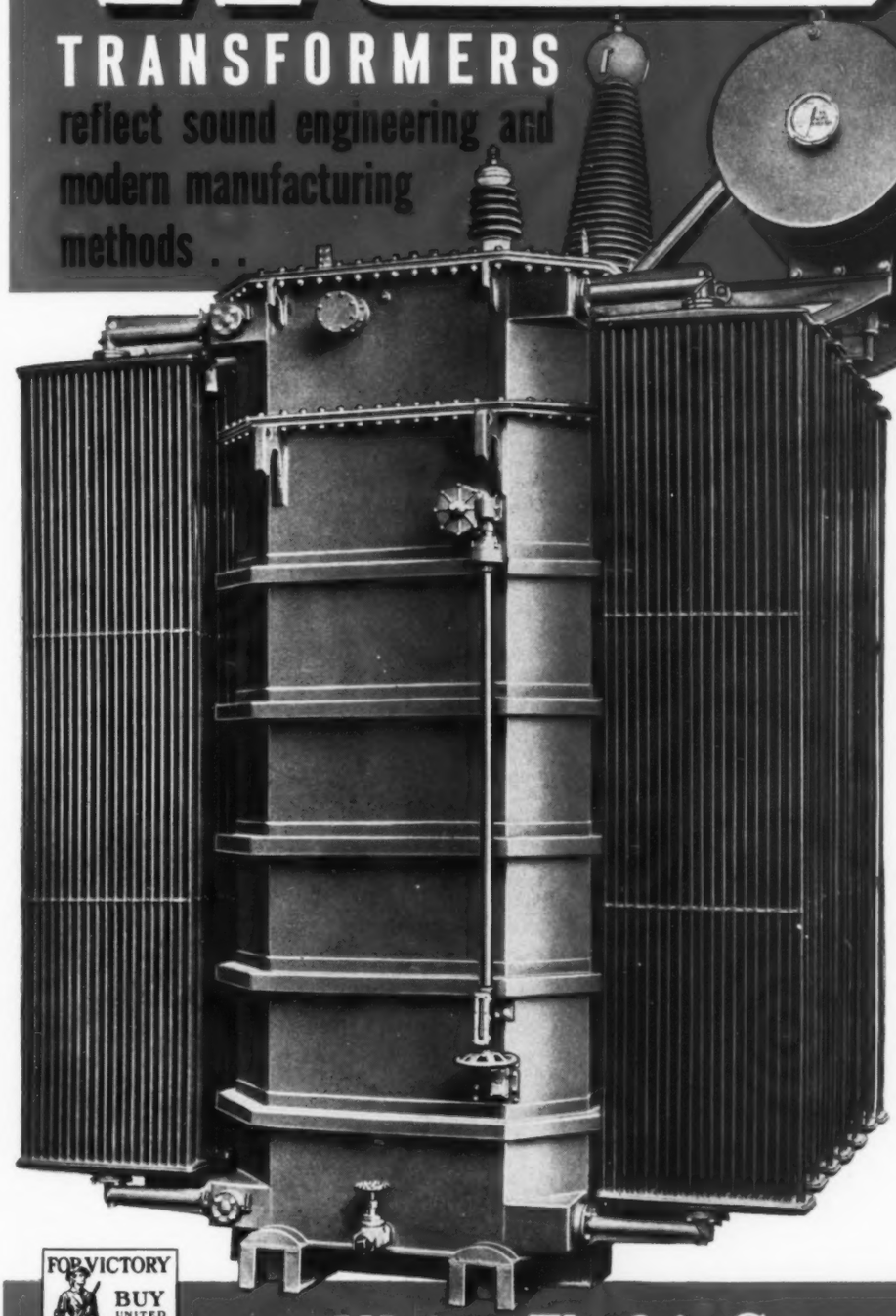

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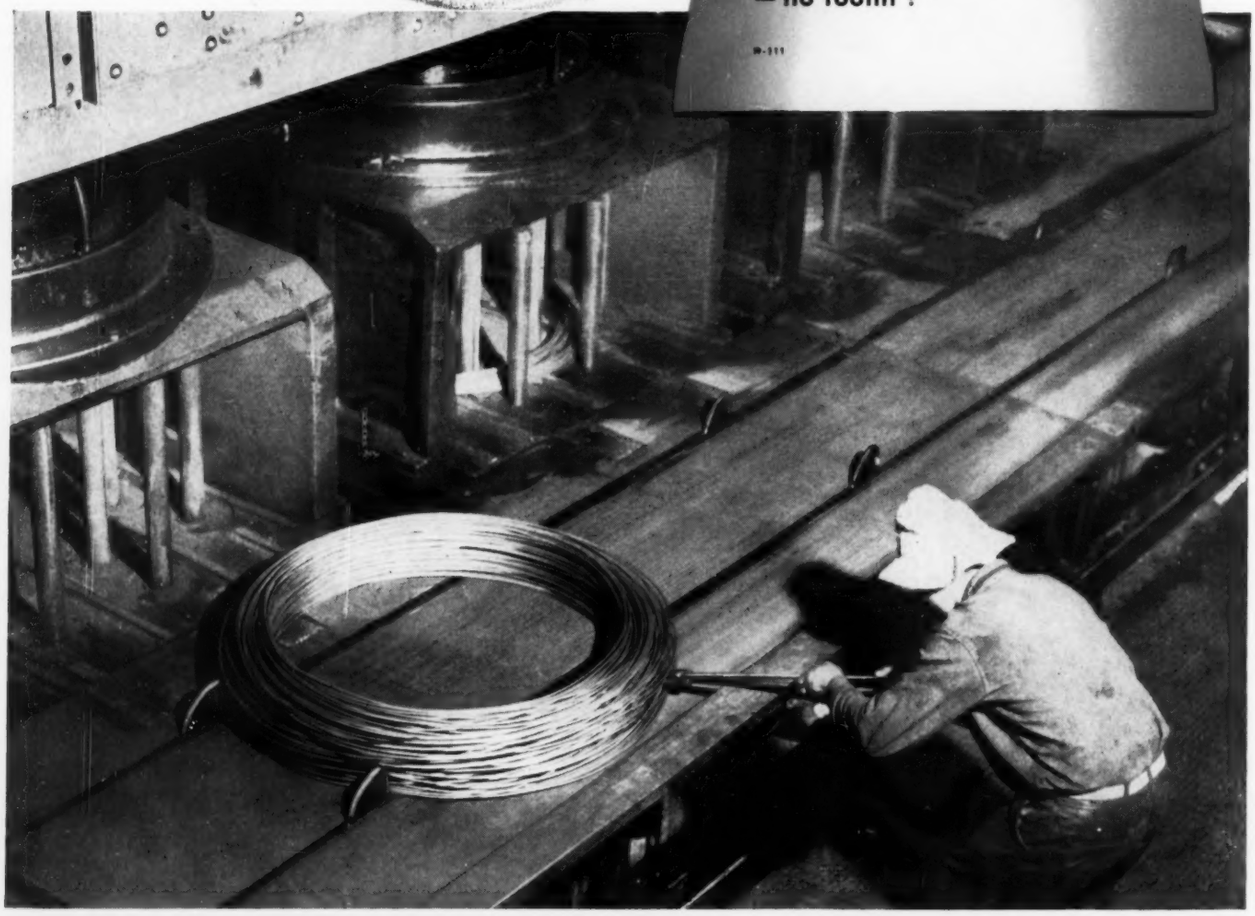

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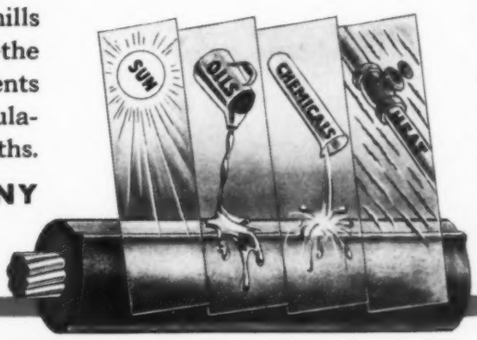

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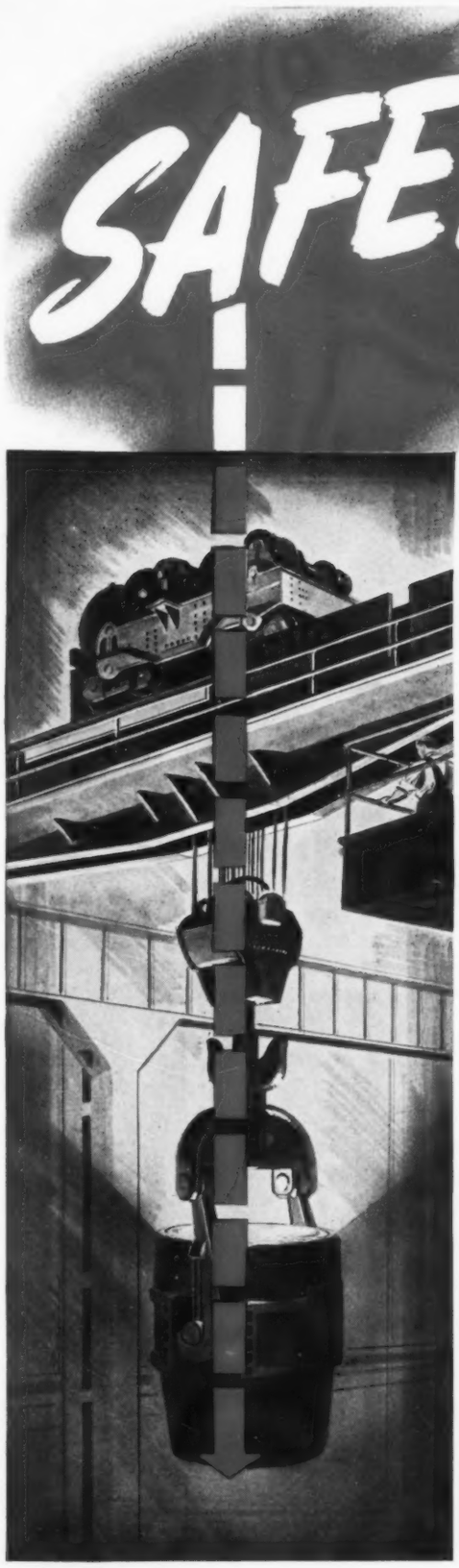

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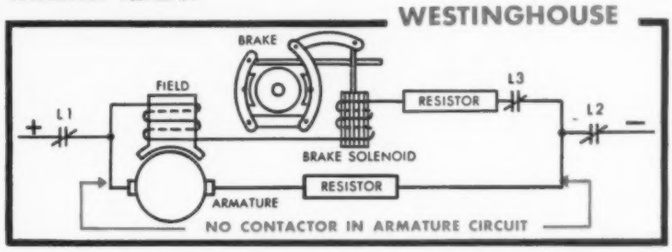

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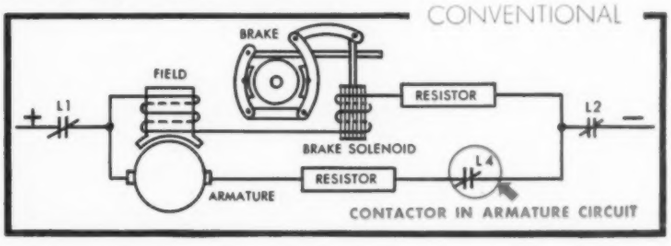

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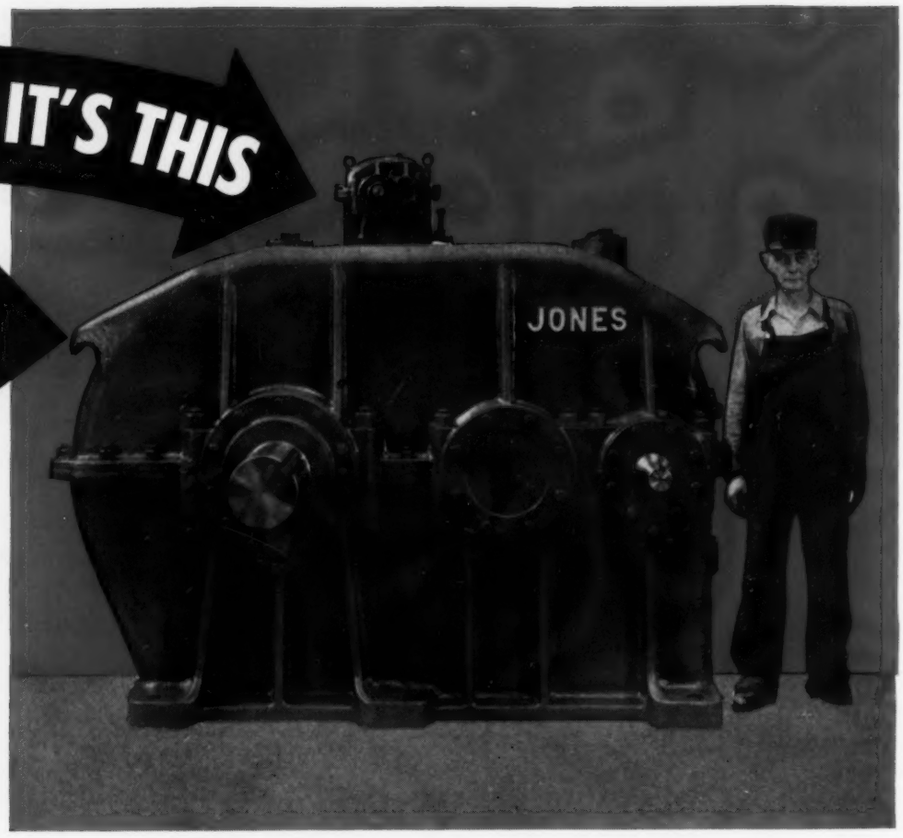
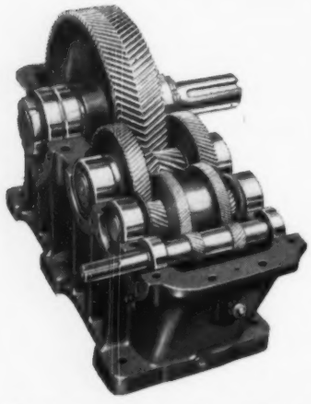


. . . both will stand up under war time conditions



The above view of a Jones Triple Reduction Herringbone Speed Reducer is typical of a line that is noted for advanced design, superior materials, precision workmanship.

TWENTY FOUR hours a day operation plus loading up to rated capacity or beyond are testing speed reducers in every type of service.

Jones Herringbone Speed Reducers are establishing remarkable service records under these conditions. One reason of course is the fact that Jones Reducers have always been rated in accordance with the recommended practice of the American Gear Manufacturers Association.

With this conservative rating policy goes sturdiness, compactness, symmetry and balance—all factors that influence maximum efficiency, long life and improved performance.

Jones Herringbone Gear Speed Reducers are built in a wide range of ratios and ratings to cover every requirement. Single (Type SH) reducers in standard ratios range from 1.25 to 1 up to 11 to 1 in ratings from 1.3 to 440 H.P. Double (Type DH) reducers are built in standard ratios from 10.9 to 1 up to 72 to 1 in ratings from 0.5 to 275 H.P. The triple reduction reducers (Type TH) cover a range of ratios from 86.9 to 1 up to 355.8 to 1 in ratings from 0.3 to 78 H.P.

All these reducers have heat treated gears, ground shafts and are mounted with anti-friction bearings throughout. Cast iron bases are available for all variations of motor assembly.

For complete information on both standard and special applications of Jones Herringbone Reducers ask for Catalog No. 70. This 128 page catalog is a comprehensive technical treatise on the whole subject of Herringbone Reducer application for all conditions of service. If you have any type of drive problem that might call for Herringbone gears we shall be pleased to send you a copy.

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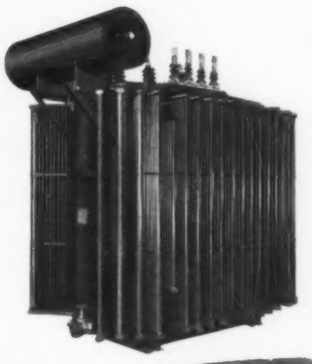
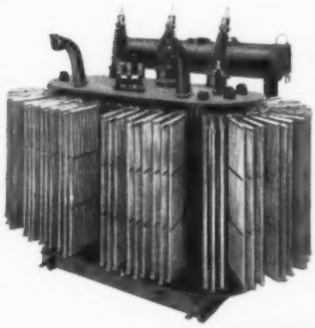
25 KV
21 DAYS OR BETTER

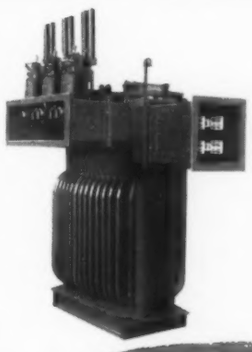


5000 KVA
34.5 KV
35 DAYS OR BETTER

10,000 KVA
66 KV
45 DAYS OR BETTER



20,000 KVA
115 KV
55 DAYS OR BETTER



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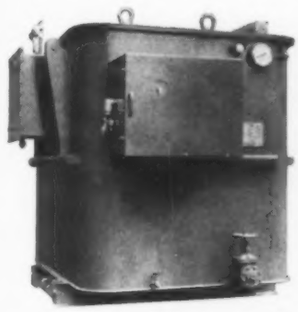
21 DAYS OR BETTER



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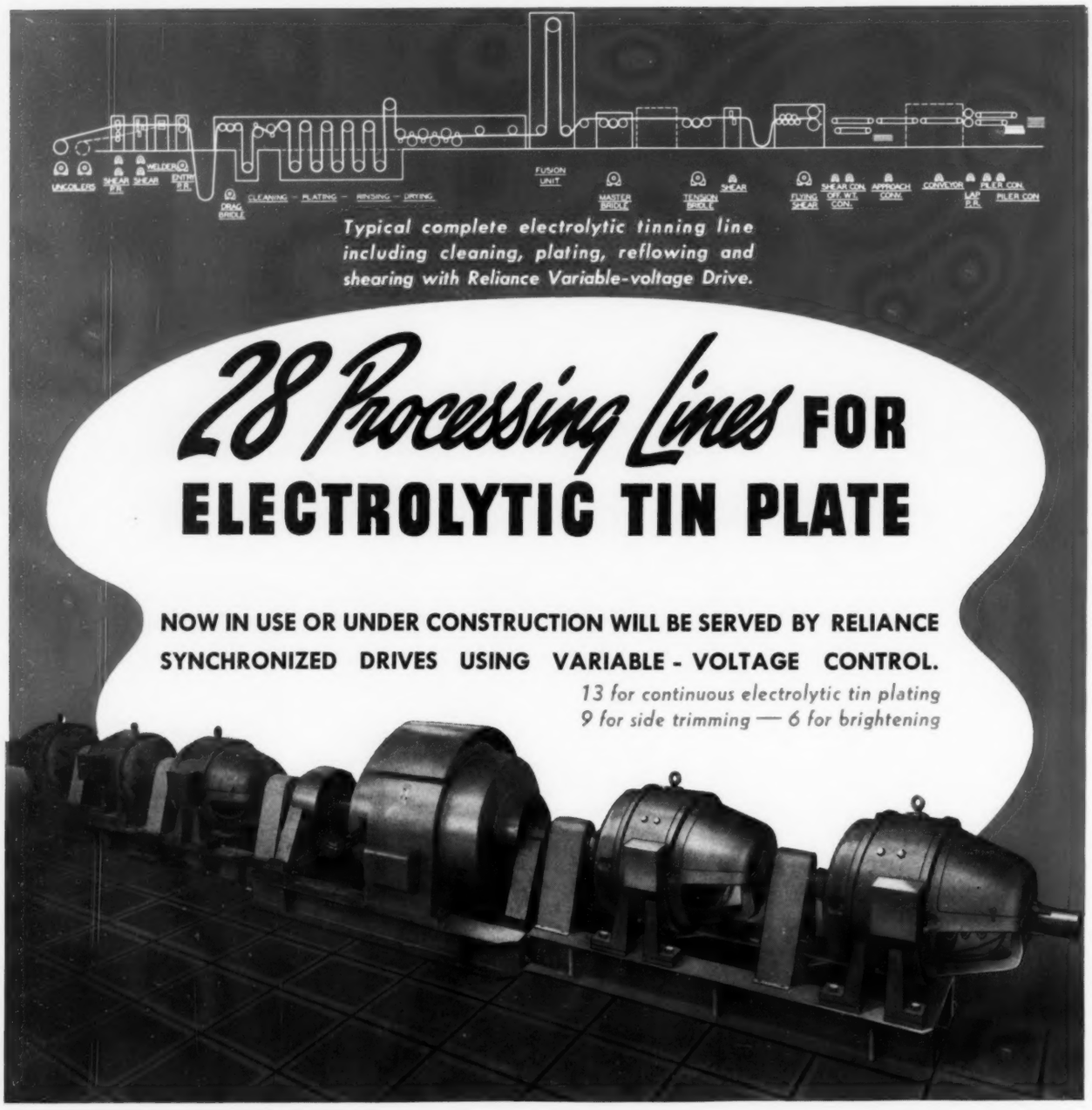

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No special padding or special foundations are required when you install a NORTH AMERICAN Turbo Blower. In an emergency, however, you can change the position of discharge, disassemble or assemble the entire machine easily and quickly.

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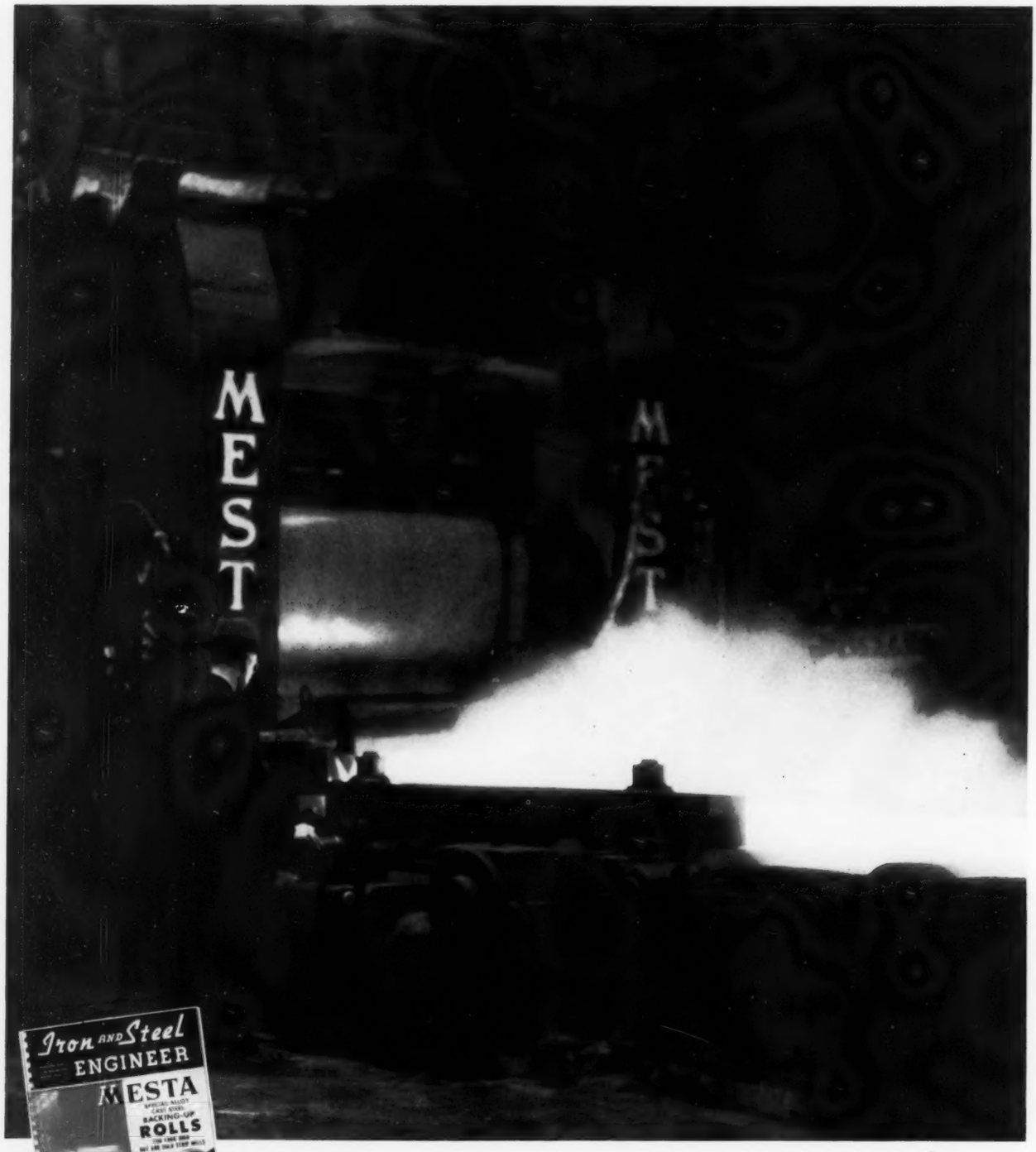

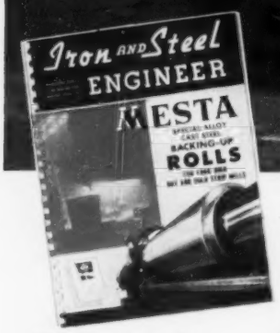

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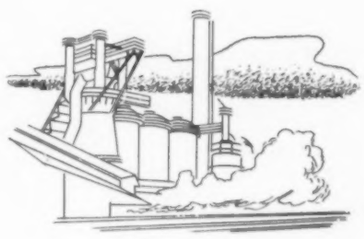


PITTSBURGH, PA.

Meet the Equipment Manufacturer

LEWIS FOUNDRY & MACHINE

Herewith is presented the fourth in a series of articles outlining the history and development of the many companies servicing the iron and steel industry. It is felt the progress of the equipment manufacturer has been so closely allied with the upward march of the steel industry that our readers would be interested in the many developments sponsored by the manufacturer which were so helpful to the industry. In later issues this series will be continued.

▲ About the time Benjamin F. Jones and James Laughlin formed a partnership to take over the American Iron Works in Pittsburgh, and while Captain Bill Jones was still a cub in the steel business, the firm of Oliver and Lewis established the third roll foundry in Western Pennsylvania on Second Avenue, Pittsburgh. Here, in close proximity to the bustling merchant iron mills and the blinking coke ovens which lined the rivers, the firm prospered, changing its name to the Lewis Foundry and Machine Company in 1863, and moving to a new location at Tenth and Bingham Streets on the south side of Pittsburgh in 1869.

Gradually expanding its line of machine tools and equipment, the company remained at its south side location until 1900, when, because of lack of room for further expansion, a 25-acre site was acquired in Robinson Township Groveton, Pennsylvania, about one mile from Coraopolis. Here a modern foundry and machine shop were erected and placed in operation in 1901, with about 130 employees. Increased business necessitated a 233 ft addition to the foundry building in 1920, when the personnel had increased to 300.

WILLIAM CORDES SNYDER, JR. — president — Lehigh University, 1925 — two years chemical analysis, Wheeling Mold and Foundry Company — to Lewis in 1927 as metallurgist and roll maker — elected vice-president in 1936, president in 1937.

BUD SCOTT PHOTO

F. O. LEITZELL — vice president — Penn State — American Locomotive — ten years with H. K. Porter — in charge of engineering and sales of sheet and tin mill equipment for Blaw-Knox for sixteen years — with Lewis since 1935 in charge of engineering and sales of rolling mill machinery.

BUD SCOTT PHOTO

BUD SCOTT PHOTO

FRED H. FANNING — chief engineer — Carnegie Tech, 1922 — wide experience in structural and mechanical design with Harbison-Walker, Dravo, Koppers, and Taylor-Wilson — joined Lewis in 1927 as chief draftsman, becoming successively assistant chief engineer and chief engineer.

BUD SCOTT PHOTO

ROY J. LECKRONE — chief designing engineer — University of Pennsylvania — various connections with steel and allied industries — three years in Russia on design and construction of rolling mill equipment.

In 1927 the company changed ownership when Frank Cordes became president and general manager, but continued to operate under the name of Lewis Foundry and Machine Company. The ownership of the company again changed in 1929, through purchase by the Blaw-Knox Company, of which Lewis Foundry and Machine is now a subsidiary.

Continued expansion of business required further enlargement of the plant and during 1936 and 1937 additions were made involving a 215 ft extension to the foundry, a 156 ft extension to the machine shop, and a research laboratory.

W. B. HACKETT — chief rolling mill engineer — University of Cincinnati — roll turner with Crucible Steel, Garrison Foundry, Seaman-Sleeth Company — with U. S. Steel, 6 years — E. W. Bliss Company 6 years — with Lewis since 1936.

BUD SCOTT PHOTO

R. B. KRAFT — manager, roll sales — Lewis Institute, Armour Institute — with Sherwin-Williams Paint Company, Cleveland-Cliff Iron Company in Cleveland — manufacturers agent in Chicago for thirteen years — with Lewis since 1938.

BUD SCOTT PHOTO

F. E. WALLING — assistant to the president — University of Montana and Lehigh — Lukens Steel, in open hearth and mills — to Carnegie-Illinois, Duquesne, as superintendent of rolling in 1938 — joined Lewis in 1941.

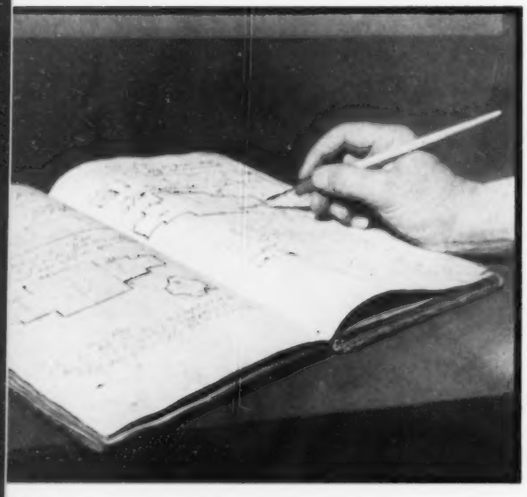
Sales personnel, left to right, J. M. Lewis, F. M. High, M. A. Nicastro, S. A. Swetonic, A. L. Ralston, W. C. Young and R. B. Kraft, center.

Employees now total about 700. The foundry, with five air furnaces and two cupolas, has a capacity of about 3500 tons per month of rolls and machine castings. Individual castings weighing up to 100 tons are made. The roll shop contains lathes up to 50 in., as well as grinders, saws, mills, centering and heading machines and other auxiliary equipment, while the machine shop provides a complete array of lathes, milling machines, post mills, boring mills, gear hobbers, shapers, slotters, etc.

Products now include a wide and varied line of equipment for steel plants and the non-ferrous industries, including mill drives and gear sets, bar and billet mills, foil mills, sheet mills, cold mills, shears, mill tables, saws, reels, coilers, pinch rolls, bar twisters, forging and straightening machines, levelers, roll lathes, grinders, etc. A complete line of large and small chilled and alloy iron rolls is manufactured for steel and non-ferrous rolling mills. Under the trade names of Lewis-X, XA Special, Superior-X, Climax, Ajax and Atlas, rolls are offered for application in hot and cold strip mills for rolling steel, nickel, aluminum, brass, copper and zinc, in plate mills, billet mills, bar mills, rod mills, rail mills, structural mills. The Atlas roll, a development of the company in 1938, is a tough chromium-nickel-molybdenum bearing iron roll having the strength of carbon steel rolls (about twice the strength of ordinary cast iron), while retaining the qualities of iron rolls which give greater tonnage, superior finish and reduced fire-cracking. It has been applied in secondary blooming mills, heavy intermediate mills, etc.

Another development of the company is the three-high sheet mill which effected marked economies in the production of sheets prior to the development of the wide strip mill.

The rolling of aluminum foil, with the problems imposed by the tissue-like gauges of the product, was satisfactorily accomplished by Lewis's development of a foil mill. One of the early aluminum strip mills was also built by Lewis. Currently in production is the plate mill for the Kaiser plant at Fontana, California, and a bar mill for Russia.



A very interesting item among the records of the Lewis Foundry and Machine Company is an old order book covering transactions from 1864 to 1871. As can be noted, engineering and sales records are combined by entering a sketch with each order. Companies listed in this book form a veritable "blue book" of the pioneers in the iron and steel industry. It is possible that the first heat of basic open hearth steel made in the United States was rolled on Lewis rolls, as Otis and Company, Cleveland, Ohio, first U. S. producers of basic open hearth steel, is recorded in this ledger.

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Rockbestos A.V.C. Power Cable (illustrated), Motor Lead Cable and Lighting and Control Wire (Underwriters' and N.E. Code, Type AVA) meet the requirements for severe service. Maximum operating temperature rating 110° C. (230° F.) For samples, catalog, and recommendations, write nearest branch office or: Rockbestos Products Corporation, 885 Nicoll St., New Haven, Conn.

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CORRECTION

In the article "Rolling Pressures in Strip Mills", by M. D. Stone and J. Greenberger, in the February issue of *Iron and Steel Engineer*, the curves used as Figure 3, page 64, are actually a part of Figure 7, page 67. The accompanying graph is the correct Figure 3 for the article.

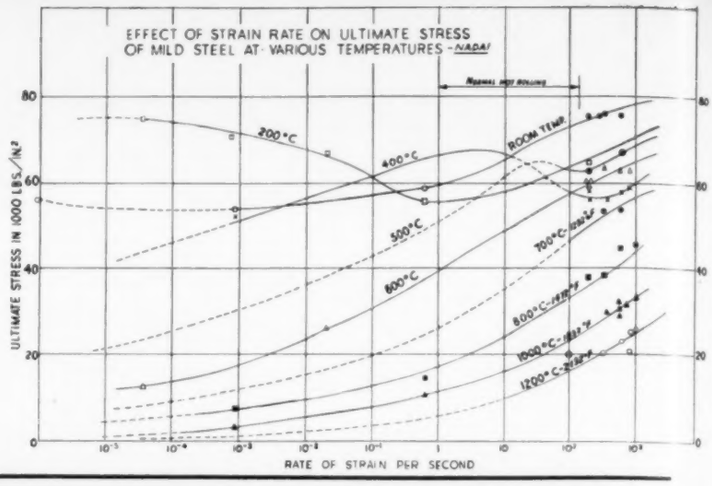

Figure 3 — Curves showing effect of rate of strain upon ultimate strength of mild steel at various temperatures.

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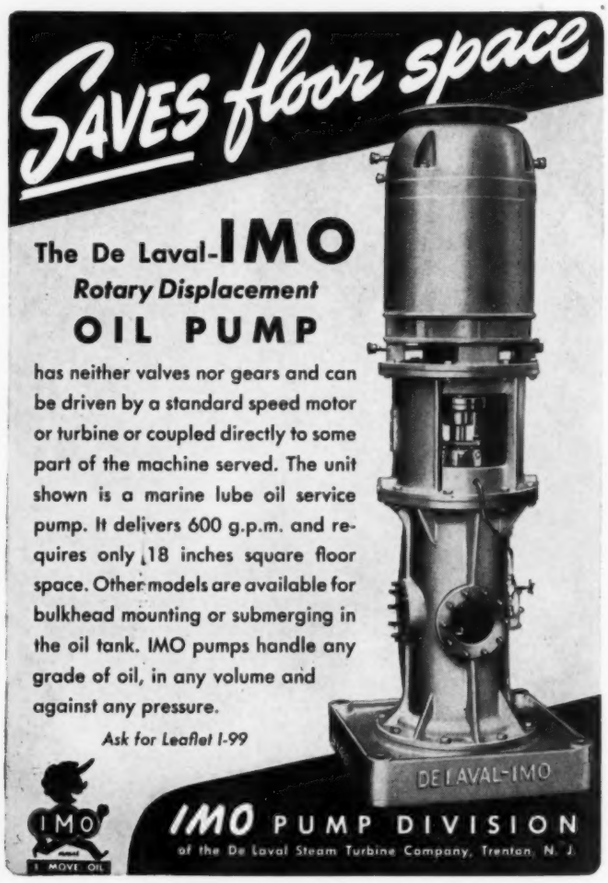
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NEW LINE OF HOISTS FOR MONORAIL TRACKS

▲ Northern Engineering Works, Detroit, has announced a line of low headroom hoists for operation on the various types of special section monorail track systems.

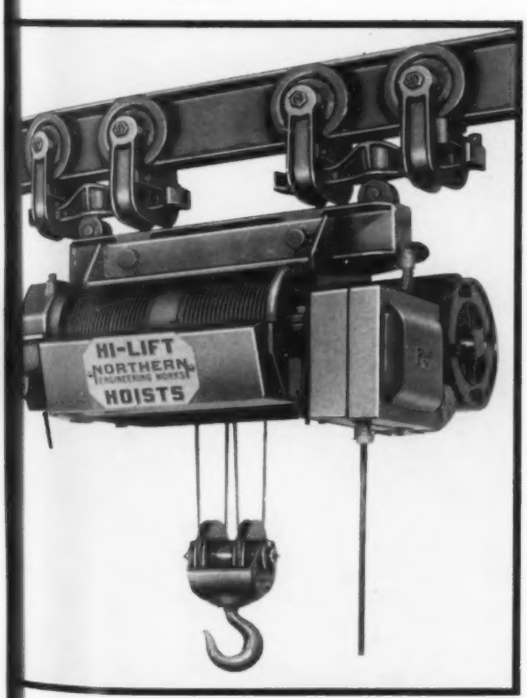
These hoists, mounted on trolleys designed to fit the monorail track system used, have the well-known Northern Hi-Lift design which provides maximum hook lift, yet had the drum parallel to the tramrail track and are built in capacities from one ton up.

The line includes both cab and floor controlled types. Any of these hoists may be furnished with the new Northern variable speed push button control.

As is the case with all Northern hoists, this tramrail line is of extremely sturdy construction. The hoist frame is rolled steel plate welded under a special process. Gearing is machine cut, heat treated to a hardness and depth that eliminates wear. Heavy duty roller bearings and splash lubrication assure low friction load and freedom from wear.

The mechanical load brake can be reached and friction surfaces replaced without removing the hoist gear case cover. Split gear case provides easy access to gearing and bearings.

This hoist, offering maximum hook lift, is built in capacities from one ton up.



MIRRORS MEASURE STEEL SLAB LENGTH

▲ A system of mirrors has been devised at the Westinghouse Research Laboratories to enable workmen to measure at a glance the width of yellow-hot steel slabs rolling shoulder high from the mill. This development of research engineer Dr. E. D. Wilson may assist in the job of speeding armor plate production in one of the nation's giant new steel mills.

In present plants the steel plates travel on a table just above the floor and can be measured with a long hand gauge. In the new mill — now being built — the plates will come out of the rolls too high to use the gauge. These plates, up to 13 feet in width, must be accurate to within one-half inch before they go to other rolls to be squeezed into long sheets. If the plate is too narrow, the sheet will be too narrow. And if the plate is too wide the excess must be cut off and scrapped, wasting vital material and production time. Without a method of measuring the slab, the mill operator would put enough force on the roll to make certain that the plate exceeded the specified width. Such guesswork would increase the amount of scrap.

Engineers designing the new plant brought this problem to the Westinghouse Research Laboratories and Dr. Wilson was assigned to work out some way of measuring the steel from a distance. With three mirrors, a pane of glass, several lights and five white lines on a sheet of black paper, Dr.

Through a system of mirrors, slab width may be accurately gauged as it emerges from the mill.

Wilson built an experimental system for measuring the width of the steel from a point 20 feet to the side of the rolls. A square of cardboard was painted red and covered with light to represent the glowing metal. The black paper chart, with its white lines showing the proper plate width, was mounted off to one side. One set of mirrors was arranged to catch an image of the glowing 'steel' and a second set was aimed at the chart. Then both of these images were directed into a mirror so that the white lines were superimposed on the image of the steel plate.

In practice, plates that fill the space between the lines would be sent on to be rolled into sheets. When the plate is too narrow, the rolling mill operator can easily estimate the amount of additional pressure needed.

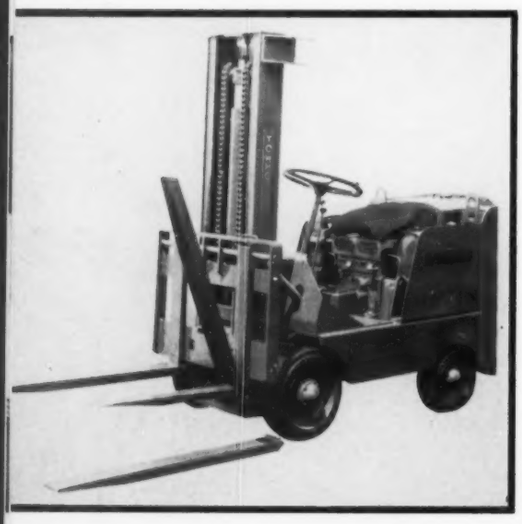
FORK EXTENSION ADAPTERS FEATURE OF NEW TRUCK

▲ The problem of handling loads of widely varying dimensions on a lift truck with standard length forks has been considerably simplified by new fork extension adaptors developed by Towmotor Corporation, Cleveland. Quickly and easily attached, the adaptors make it possible to extend fork lengths safely as much as 24 inches in only 15 or 20 seconds. Thus skids or pallets need not conform to a minimum size range to be efficiently accommodated by the same lift truck.

Adaptors are attached as shown in the illustration. When adaptors are held vertically, the eye at the bottom of each is inserted over forks. The adaptor is then slid back to the bend of the forks, and lowered. It automatically "locks" in position to prevent forward or backward sliding, while side flanges prevent any sideway slipping.

Another new refinement to permit extremely flexible lift truck operation with standard models, the new Towmotor extension fork adaptors have many applications to the materials handling problems growing out of conversion, dynamic war production methods, and reconversion. Complete information may be had by writing Towmotor Corporation, Cleveland, Ohio, and mentioning this publication.

These fork extension adaptors permit the handling of loads of widely varying dimensions.

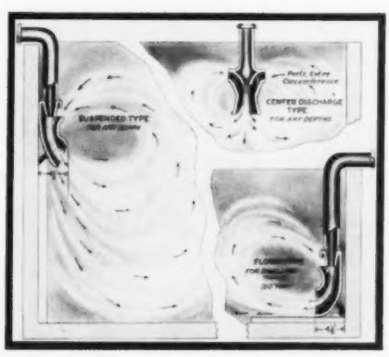


STEAM JETS FOR VARIED APPLICATIONS

▲ Three new circulating steam jets have been announced by the Duriron Company of Dayton, Ohio. In addition to being corrosion-resisting, these jets are said to have the advantage of fitting snugly to the inside walls of either square or circular tanks, with a maximum projection of 4½ inches. The suspended and center discharge types may be used in tanks of any depth. The floor type is adaptable for tanks of any depth up to 60 inches. All types are so designed as to give complete agitation and circulation of the tank contents.

Made of the high-silicon iron alloy Duriron or the special stainless steel Durimet, they are highly efficient for heating acid solutions, dissolving powdered or lump chemicals, and for the digestion of ores and separation of sludge acids.

The compact design of these corrosion-resistive circulating steam jets aids in their installation in tanks.



TONS OF TROUBLE FOR HITLER AND TOJO

Pictured here for the first time is one of the Army's latest weapons for land combat. It is a newly designed "tank destroyer," a speedy, maneuverable land cruiser with great firepower. Notice the sloped contour of the hull and turret to deflect enemy shells. This destroyer, known as the M-10, is pictured during a test at the arsenal of the Fisher Body Division of General Motors, where it was designed and where it now is being produced in large numbers.

INDUSTRY SPENDS VAST SUMS FOR EXPANSION

▲ When the current steel industry expansion program is completed this year, blast furnace capacity will be 20 per cent greater than at the start of 1938, open hearth capacity will have been increased about 18 per cent, and electric furnace capacity will be three and a half times what it was in 1938.

In revealing these figures, the American Iron and Steel Institute reported that steel companies have invested $1,205,000,000 of their own funds to enlarge and improve equipment since Hitler moved into Czechoslovakia and Austria.

Approximately $432,000,000, or about one-third of the total was spent during the years 1938 through 1940 when hostilities were beginning and spreading through Europe.

From 1941 through 1943, the industry spent or is preparing to spend $773,000,000, nearly twice the amount spent during the preceding three years. The industry's own expenditures for this purpose were augmented, beginning in 1941, with appropriations from government funds to install certain new equipment wanted for special war work.

Combined total of government and private expenditures contemplated for 1943 to expand and improve iron and steel plant facilities is nearly $650,000,000.

About 30 per cent of that total will be devoted to installing additional blast furnace and steel making capacity.

Another 15 per cent will be used to provide additional rolling mill facilities, and the remaining 55 per cent will be spent to install other needed equipment, mostly in finishing departments.

The large-scale expenditures for new equipment are reflected in greatly increased capacity for producing iron and steel products. Much of the new capacity thus installed was built before the nation entered the war, and so was quickly available when the emergency arose.

Program designed to increase pig iron production by an estimated average of 50 tons per blast furnace daily through improvement of the quality and uniformity of coke was suggested recently by Bureau of Mines officials.

Complete success of the program, which is being operated by the Office of Solid Fuels, the Bureau of Mines and a government-industry committee, would increase the production of pig iron to an amount equal to the production of three new blast furnaces of 1000 tons daily capacity, principally by better cleaning, grading and handling of coals and cokes and removing certain sulphurs.

Steps already are being taken to remedy coke problems limiting pig iron production and material progress is being made, it was said.

Technical changes in industry operations necessary to carry out the program were outlined recently in New York at the annual meeting of the American Institute of Mining and Metallurgical Engineers, in a paper prepared by L. D. Schmidt, Pittsburgh, Bureau of Mines chemist; W. C. Schroeder, assistant chief of the bureau's Fuels and Explosives Service, and A. C. Fieldner, chief of Fuels and Explosives Service, Bureau of Mines.

A Coke Production Committee, which was a highly important factor

CROUSE-HINDS
OBROUND
CONDULETS

The *Wedge-Nut* Fastener

Securely holds the cover or wiring device, and it cannot become loosened by vibration.

No Lugs

There are no lugs in either the wiring chamber or the cover opening.

Easy to Pull Conductors

They have unobstructed cover openings; therefore, it is easy to pull conductors without injury to them.

Splicing and Taping

The unobstructed cover opening and large wiring chamber make easy work of splicing and taping.

A Nationwide Distribution Through Electrical Wholesalers

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in developing the program is now helping to put its proposals into effect, includes the following: Mr. Fielder, chairman; W. T. Brown, Jones and Laughlin Steel Corporation; A. R. Powell, Koppers Company; C. D. King, United States Steel Corporation; W. A. Haven, Arthur G. McKee and Company; H. M. Crossett, Bethlehem Steel Company; Hjalmar Johnson, Inland Steel Company; Samuel Weiss, War Production Board; Harlen M. Chapman, assistant deputy, Solid Fuels Coordinator for War, and H. P. Zeller, Jamison Coal and Coke Company.

PLANERS AND HOBBERS SHIPPED FROM BRITAIN

▲ Five huge metal-working machines, shipped from Great Britain early in 1942, are helping to produce propulsion sets at a New England General Electric plant for cargo vessels essential to carrying on the allied fight against the Axis.

The machines were shipped from Great Britain to a new General Electric plant when it was impossible to get such apparatus from American sources in time to meet production requirements. Ironically, the move not only aided United States production, but also cheated the Axis of a chance of destroying some of the machines inasmuch as the points at which they had been installed, or were to be installed, in Britain were subsequently bombed.

Of the five giant machines, two are planers, used to remove large quantities of metal from flat surfaces of gear casings weighing up to 20 tons each. One of these planers is about 70 feet long by 30 feet wide by 20 feet high. Three large casings can be machined on this planer simultaneously. The other three machines are hobbers which are used to cut the teeth in large low-speed gears that transmit power for driving the propellers. Some of these gears weigh as much as 35 tons.

One of the planers had been intended for installation at Sheffield. The other had already been installed and was in use at Sheffield, but was torn down and shipped to America when the need for the equipment developed here. These two machines, in all probability, escaped destruction when the city was subsequently attacked by Axis raiders.

One of the gear hobbing machines was removed from a British plant at Manchester, and the other two from Belfast, Ireland. Shipment of the five mammoth machines from Britain was accomplished under a cloak of great secrecy. The machines were shipped in separate vessels, at different dates, to minimize the possibility of damage to the entire group. One of the ships was attacked during the crossing and sustained some damage, but made its American port safely with the precious machine it was carrying.

NEW BLAST FURNACE BLOWN IN AT DULUTH

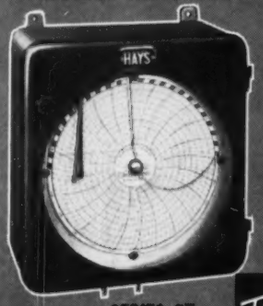
▲ Duluth's iron and steel making facilities were increased by over a quarter-million tons of pig iron annually when the newly completed blast furnace was blown in recently at the Morgan Park plant of the American Steel and Wire Company, U. S. Steel Corporation subsidiary.

Following the blowing in of the furnace, prominent officials of the Defense Plant Corporation War Pro-

A Real Aid to PRODUCTION

TYPE CDE-X FURNACE PRESSURE CONTROLLER

SERIES FOT PRESSURE INDICATOR



SERIES OT PRESSURE RECORDER

HAYS OPEN HEARTH PRESSURE CONTROL

TONNAGE can be increased through more even operation and even operation also means fuel saving. Automatic control of furnace pressure, rates of fuel and air flow, ratio of fuel to air, constant volume or pressure of oil or gas relieves the operators of many time-consuming details, allowing them to pay more attention to the steel making process.

When desired, the control of these various functions can be handled manually from a centralized panel through remote operation. Hays control is all-electric, simple to install, simple to operate, simple to understand.

The following Hays instruments may be used effectively in combination or separately for the functions indicated.

Type CDE-X Furnace Pressure Controller with external manual adjustment for automatically operating stack damper to hold pressure constant.

Series FOT Pressure Indicator provides an easily read measurement of furnace pressure. Usually connected at furnace roof.

Series OT Pressure Recorder provides daily record (24 hr. chart) of furnace pressure. Shows timing of reversals and each change of pressure made by operator during the heat.

Hays partial or complete instrumentation is a REAL AID TO PRODUCTION. Hays representatives located in the principal cities of the U.S.A. and Canada will gladly supply complete information.

THE HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

duction Board and top executives of the American Steel and Wire Company witnessed a cast of pig iron at the official dedication ceremony.

The new furnace, capable of producing approximately 800 tons of pig iron daily, replaces an old one dismantled and scrapped several years ago. Moved here last summer from Joliet, Illinois, it has been modernized with funds provided by the Defense Plant Corporation in order that the American Steel and Wire's manufacturing facilities at Duluth might better serve the nation's war effort at the earliest possible moment.

The construction of an entirely new blast furnace ordinarily requires the greater part of two years to complete, whereas the new addition to the Duluth plant was completely dismantled at Joliet and moved some 450 miles and rebuilt on modern lines in less than one year, an outstanding achievement in blast furnace construction.

In addition to the blast furnace in the reconstruction program of dismantling and moving was considerable auxiliary equipment, including a boiler house, stoves, blowing engines and stock house equipment. The entire job of moving and construction necessitated the shipment of more than 400 carloads of material, machinery and parts, including new firebrick for the lining of the furnace.

PRIORITIES DELAY

GENEVA STEEL WORKS

▲ Construction of the $150,000,000 Geneva Steel Works near Provo, Utah, is progressing as well as can be expected in the face of a difficult priority situation, according to officials of Columbia Steel Company. It is now estimated that the Geneva plant will not be in operation much before the end of 1943, despite previous midsummer estimates.

Now that parts of the huge steel plant are well into the steel erection stage and other parts are fast approaching that stage, the stringent steel priorities are operating to slow up construction.

This largest integrated steel mill west of the Mississippi is being built by Columbia Steel Company, U. S. Steel subsidiary, for the Defense Plant Corporation. It is designed to help supply the war shipbuilding needs of the Pacific Coast. When completed, the Geneva plant will supply an additional 750,000 tons of steel yearly for war purposes.

The raw materials — coal, iron ore, limestone, etc.— to feed 252 coking ovens, three pig iron furnaces, and nine steel furnaces will be obtained in Utah. Steel plates and structural steel will be the end-products of the operation. In addition to steel, four batteries of coking ovens will supply considerable quantities of tar, gas, ammonium sulphate, motor fuel, etc. as by-products of the coke conversion process.

To assure a constant supply of coking coal, the new Geneva Coal Mine has been developed and is in production in southeastern Utah with a possible daily capacity of 8,500 tons. The iron ore will come from Columbia Steel Company's open pit mines in southern Utah, which are being greatly expanded. Limestone will be secured from large deposits near the steel plant.

For many years, Columbia Steel Company has been operating a blast furnace at its Ironton Plant near Provo, Utah. The national govern-

FORECAST:

Some day, you'll look up to this device

BASIC

in modern mill practice

This is the patented, exclusive Kemp Industrial Carburetor, the machine that provides complete premixing of gas and air to provide new savings, new heat liberation, new flexibility and new control in almost every type of ferrous and non ferrous heat processing.

As the basic unit in Kemp heat treating the Industrial Carburetor supports gas immersion melting in modern tin stacks, provides fuel for inert gas and for recirculating radiators in annealing covers, for Kemp Radiatube Roll Heaters, may be set for exactly the desired flame characteristics whether reducing, oxidizing or for complete combustion . . . and save 15 to 40 percent in fuel.

For engineering details and assistance, address **The C. M. Kemp Manufacturing Company, 405 East Oliver Street, Baltimore, Maryland**

The Army-Navy "E" Flag, awarded "for high achievement in the production of materials of war."

KEMP of BALTIMORE

ment, through the Defense Plant Corporation, is adding another larger blast furnace, which is scheduled to go into production of pig iron around the first of March. It will produce about 950 tons of iron daily destined for the Pacific Coast war effort.

WEIRTON SETS NEW PRODUCTION RECORD

▲Weirton Steel Company, Weirton, West Virginia, established a new record in production of steel ingots in February. The company's joint labor management committee made the following announcement:

"Beating all three previous production records established by the company, this new production record stands as an all-time world's high for production of steel ingots from 12 stationary open-hearth furnaces. In February the average daily production of steel ingots was 5147 net tons, which exceeded by 67 tons the previous record established last December. New records also were reported for finishing mills.

RECORDS BROKEN AT STEEL AND WIRE

▲ An excellent start was made during the month of January by plants of the American Steel and Wire Company in their production for victory. A total of 74 new production records was established during the month by the company, which is a subsidiary of the United States Steel Corporation. During the full year, 1942, the wire company broke a total of 901 old records.

The Worcester, Massachusetts, operations set the pace for other districts during the past month by breaking a total of 30 records, 16 of them at North Works and 14 at South Works. Cleveland, Ohio, plants established 20 new highs, 9 of them being recorded at Consolidated Works, 5 at Cuyahoga Works, 4 at American Works and 2 at Newburgh Works. Donora, Pennsylvania, Steel and Wire Works broke 13 records while the Joliet, Illinois, operations broke 5, New Haven, Connecticut, 4 and Allentown, Pennsylvania, 2.

NEW COKE OVENS PUT IN OPERATION

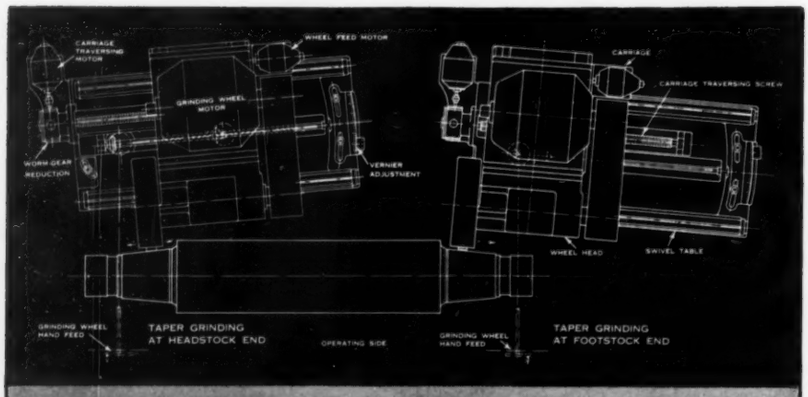
▲ Republic Steel Corporation's new 61-oven by-products coke plant at Warren has been placed in operation.

Coke from the new battery will supply the fuel for the 1,100 ton blast furnace which was lit at Republic's Youngstown plant on October 12, 1942. The battery, with a capacity of more than 1,000 tons of coke daily, was built by Republic for the Defense Plant Corporation to supplement the 63-oven by-products plant at Warren and the huge by-products plant at the Youngstown works.

The new by-products plant and exhauster will not be completed for several months.

CRITICAL MATERIALS FROM SALVAGE DRIVE

▲ General Electric plants during 1942 salvaged 388,300,000 pounds of scrap for reuse in war production, it was announced today by H. J. Beattie, of the company's general manufacturing organization. The scrap saved would fill every car in more than 100 average freight trains.

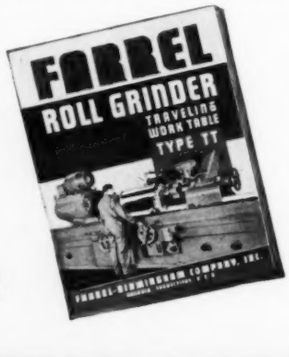


HOW YOU CAN *REDUCE TIME* GRINDING TAPERED ROLL NECKS

In a Farrel Type TT Roll Grinder equipped with tapering attachment, tapers can be ground on both roll necks, and the body can be finish ground, without disturbing the original setting of the roll. This reduces to a minimum the total time for grinding, and in addition guarantees a true roll.

As shown in the diagram, the position of the roll remains fixed on the traveling work table. The swivel table carrying the grinding wheel is offset in one direction for one neck and in the opposite direction for the other neck. A simple adjustment gives the exact amount of taper without manipulating the footstock or other units of the machine. Any commercial roll neck taper can be accurately reproduced.

Farrel Roll Grinders have many other important features which contribute to superior performance, better finish and increased output. For complete details write for a copy of Bulletin No. 113.



FARREL FARREL-BIRMINGHAM COMPANY, Inc.
ANSONIA, CONN.
New York • Buffalo • Pittsburgh • Akron • Los Angeles

New Literature

▲ Power and distribution transformers and other electrical distribution equipment important in maintaining an efficient flow of power to vital war industries are completely described in a new bulletin just issued to cover the entire line of this Allis-Chalmers equipment.

The new book discusses important wartime considerations such as the use of modern welded construction and standardization of design, which saves vital materials in manufacturing and provides the advantages of interchangeability in installation.

The new electro-cooler for increasing transformer capacity, and unit substations which simplify power control and distribution are two new developments treated in Bulletin B-6186. Others included are feeder voltage regulators, instrument and metering transformers, the oil-sealed inert gas system which protects transformer oil by isolating it from the outside air, and load-ratio-control for load regulating voltage, power factor and phase angle.

Copies of this Bulletin B-6186 are available on request from the Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin.

▲ Because the war program has made so much more than usually urgent the need for heat-treated production parts which have intensely hard, wear-resistant surfaces, the nitriding process is assuming a timely importance. Where this process is correctly applied, rejects are practically unknown . . . an important advantage today when time and materials are so scarce.

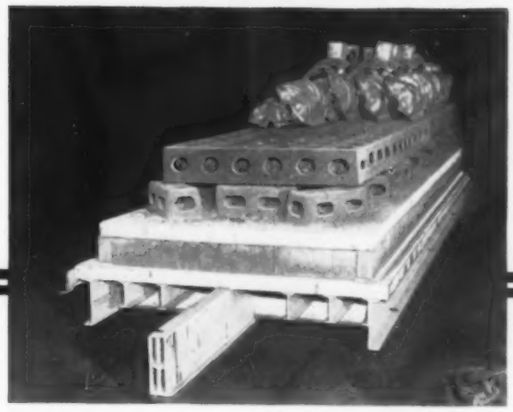
Realizing that many production men, who never before had occasion to become familiar with the nitriding process, now are vitally interested in its advantages, the Leeds and Northrup Company has just reissued a revised edition of its catalog describing the HomoNitriding Method.

Based on the system of forced-circulation familiar to all users of Homo Tempering and Homocarb Carburizing Furnaces, the Homo Nitriding Method is said to give heat-treaters precise control of the three important variables . . . nitriding temperature, flow and distribution of ammonia gas, and duration of treatment. Control of these factors is said to enable men not only to nitride parts to exact specifications in substantially less than the usual time, but also to control each batch of work so systematically that they can work progressively toward the best results.

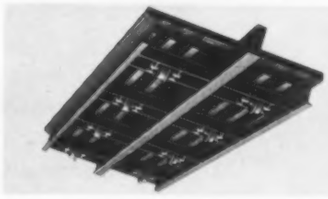
A copy of this illustrated 19-page publication will be sent promptly to anyone interested. Just address Leeds and Northrup Company, 4934 Stenton Avenue, Philadelphia, Pennsylvania, and ask for Catalog T-624.

▲ The Ohio Electric Manufacturing Company announces the availability of a new eight page bulletin No. 210. This bulletin describes the several types of electric motors manufactured by this company. The bulletin gives the range in voltage, speed and horsepower available. Interested parties may have a copy of this bulletin No. 210 by addressing The Ohio Electric Manufacturing Company, 5900 Maurice Avenue, Cleveland, Ohio.

Phillips
FURNACE CARS



for Industrial Furnaces



HERE is a sturdy PHILLIPS car-bottom furnace car serving unlimited heat-treating hours in a vital steel plant. Note the PHILLIPS rugged underbody construction!

Built to any specifications, PHILLIPS Furnace cars are available for either existing or newly designed furnaces.

To speed furnace production, install the PHILLIPS Transfer Cars—constructed to move one or two Furnace Cars laterally.

Manufacturers Since 1868

PHILLIPS MINE AND MILL SUPPLY COMPANY

Pittsburgh, Penna.

MINE AND INDUSTRIAL CARS • FABRICATED STEEL • IRON CASTINGS

TO EXECUTIVES:

NOW YOU CAN HELP

Even More...

New Treasury Ruling Permits Purchases UP TO $100,000, in any Calendar Year, of Series F and G WAR BONDS!

The Treasury's decision to increase the limitations on the F and G Bonds resulted from numerous requests by purchasers who asked the opportunity to put more money into the war program.

This is not a new Bond issue and not a new series of War Bonds. Thousands of individuals, corporations, labor unions, and other organizations have this year already purchased $50,000 of Series F and G Bonds, the old limit. Under the new regulations, however, these Bond holders will be permitted to make additional purchases of $50,000 in the remaining months of the year. The new limitation on holdings of $100,000 in any one calendar year in either Series F or G, or in both series combined, is on the cost price, not on the maturity value.

Series F and G Bonds are intended primarily for larger investors and may be registered in the names of fiduciaries, corporations, labor unions and other groups, as well as in the names of individuals.

The Series F Bond is a 12-year appreciation Bond, issued on a discount basis at 74 percent of maturity value. If held to maturity, 12 years from the date of issue, the Bond draws interest equivalent to 2.53 percent a year; computed on the purchase price, compounded semiannually.

The Series G Bond is a 12-year current income Bond issued at par, and draws interest of 2.5 percent a year, paid semiannually by Treasury check.

Don't delay—your "fighting dollars" are needed *now*. Your bank or post office has full details.

Save With . . .

War Savings Bonds

This space is a contribution to America's All-Out War Program by Iron and Steel Engineer

SHIP, CAPTAIN AND CREW

UP IN THOSE CLOUDS enemy bombers are hunting them. Behind, an Axis submarine trails them toward the setting sun. There's a hurricane brewing. Bravely they steam along.

Providence be with this valorous gambling team—ship, captain and crew. On trips of peril they plow on, delivering the goods of war, thoughtless of self. The jobs these merchantmen perform to save democracy rank with the noblest exploits of American pioneers. We at home should do more to pay them tribute, help them win, by working harder, giving more for bonds of Victory!

* * *

Castings for this ever-growing fleet of merchantmen are part of Continental's war production. In addition, Continental Rolls, in mills throughout America, are rolling the steel plate that goes into these ships. Thus, in war, our work at Continental is doing a job we prepared for in peace. In the manufacture of steel castings our production is among the largest in the country. Over twelve years ago Continental pioneered the High Production Rolls used today for all high-speed strip mill operation.

CARBON AND ALLOY STEEL CASTINGS • ROLLS • ROLLING MILL EQUIPMENT • SPECIAL MACHINERY

CONTINENTAL
ROLL AND STEEL FOUNDRY COMPANY
CHICAGO • PITTSBURGH

MAKE THE LOAFERS WORK

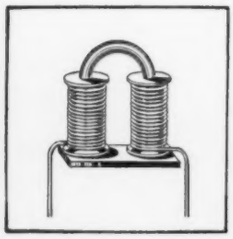
Time was when amps given to galivanting were allowed to get away with it. Kittenish kilowatts could stray from their work of running motors, and nobody bothered to make them behave. That, of course, was yesterday.

Today, these culprits are being rounded up and made to work, because industry needs all available help in producing power. The quick way to make loafing amps work is to equip your motors and generators with the right brushes. How can one know for sure which brushes are "right"? By asking SPEER — with forty-five years experience in brush pioneering and commutation engineering. SPEER will be glad to recommend the grade of brush with best characteristics for any specified job. There is no charge for this service — it is part of SPEER'S effort to speed victory. Here is all you need do: request a SPEER Brush Data Form for each motor, generator or rotary you wish to improve. Return the filled-in forms to SPEER. You will receive prompt recommendations based on unmatched experience. The rest is up to you.

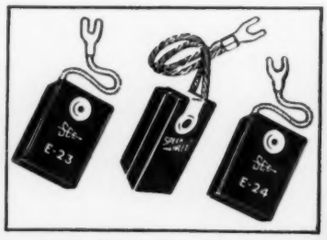
PROMOTE COPPER SALVAGE

Save the shunts and connections from discarded brushes. This helps to salvage copper needed for war material. Keep it moving to your salvage dealer as fast as it is accumulated.

Famous American Firsts



Electro-Magnet, 1828



SPEER BRUSHES— To meet the requirements of most industrial motors, SPEER Electro-Graphitic Brush grades E-23 and E-24. Also available as Multiflex Brushes. Write today for complete descriptive catalog.
There is *one right* brush grade for every job—and SPEER makes it.

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CARBON COMPANY
ST. MARYS, PA.
CHICAGO · CLEVELAND · DETROIT
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3870

ITEMS OF INTEREST

James O. McDowell has been appointed plate mill superintendent for the Kaiser Company at Fontana, California. His first job was on the sheet plate and jobbing mills of the Wheeling Steel Corporation from 1909 to 1924. From 1924 to 1929 he served as assistant superintendent of the American Mond-Nickel Company at Clearfield, Pennsylvania. In 1929 he was made superintendent of the sheet department, International Nickel Company at Huntington, West Virginia, leaving there in 1939 to become associated with Gordon Lubricator Division of the Blaw-Knox Company. Since 1941 he has been superintendent of plate mills at Dominion Steel and Coal Company, Ltd., Sidney, Nova Scotia.

J. H. Krause has been appointed merchant mill superintendent for the Kaiser Company, Fontana, California. Mr. Krause has been identified with the steel industry as a roller and in various supervisory capacities since 1901, at which time he started to work as a roller on the 12 inch 3 high mill of the United States Steel Corporation at Milwaukee, Wisconsin. He was at the Gary plant of Illinois Steel Company from 1910 to 1917, and spent the next three years with the Lackawanna Steel Company, Lackawanna, New York. From 1920 to 1930 he worked at the Canton plant of United Alloy Company, and went with Great Lakes Steel Corporation in 1930 as superintendent of their merchant mill. From 1941 to 1943 Mr. Krause was with the Crucible Company of America being located at Syracuse, New York.

Harry E. Beane has been appointed sales manager of the Bristol Company, Waterbury, Connecticut. He became identified with the Bristol sales engineering organization in 1920 and five years later was appointed district manager of the company's Birmingham, Alabama office. In 1930 he became district manager of the Pittsburgh district and in 1936 was promoted to field sales manager to supervise the activities of the company's branch factories at Chicago, Akron and San Francisco and to supervise the work of the company's district managers, sales engineers and service engineers throughout the country.

H. E. BEANE

L. G. Bean has been appointed vice-president in charge of engineering and sales for the Bristol Company, Waterbury, Connecticut. A graduate of Worcester Polytechnic Institute, Mr. Bean became associated with the Bristol Company in 1920 as sales engineer. In 1921 he became district manager of the company's Boston district; in 1925 he was made Chicago district manager, and in 1930 he returned to Waterbury as assistant chief engineer of the Bristol Company. In 1935 Mr. Bean was appointed sales manager, subse-

JAMES O. McDOWELL

J. H. KRAUSE

quently becoming vice-president and general sales manager.

Benjamin J. Harlan, superintendent of blast furnaces, Lackawanna plant of Bethlehem Steel Company, has resigned to become associated with the Lone Star Steel Company, Daingerfield, Texas. Mr. Harlan had been associated with Bethlehem 20 years.

S. B. Taylor, works manager of the Reliance Electric and Engineering Company, Cleveland, since 1931, was elected manufacturing vice president at a meeting of the company's directors, recently it was announced by Clarence L. Collens, president.

Officers re-elected by the directors were Mr. Collens, president; H. Morley Hitchcock, vice president and treasurer; A. M. MacCutcheon, engineering vice president; James W. Corey, sales vice president; C. V. Putnam, secretary; and H. F. Walters, assistant treasurer.

A native of Kentucky and a graduate in electrical engineering in 1924 from Purdue University, Mr. Taylor took an additional year of post-graduate work in business administration at the University of iIllnois before coming to the engineering department of Reliance. He transferred to the manufacturing department of the company in 1930 and became works manager a year later. He was elected a director of the company in 1935.

J. K. Mahaffey is now associated with George H. Criss, representing Baker-Raulang Company, Economy Engineering Company, Silent Hoist Winch and Crane Company, International Conveyor and Washer Corporation, Lyon-Raymond Corporation, and Detroit Hoist and Machine Company in the Pittsburgh district.

CHARLES H. MANION

BUD SCOTT PHOTO

A graduate of Penn State in 1906, Mr. Mahaffey started with General Electric Company in Schenectady, New York, and Cleveland, Ohio, before coming to Pittsburgh where he represented the Adams-Bagnall Electric Company, Union Metal Manufacturing Company, and

J. K. MAHAFFEY

Electric Products Company. For the past 26 years he has acted as Pittsburgh representative of Thomas A. Edison, Inc.

Charles H. Manion, vice president in charge of operations of the Follansbee Steel Corporation, has been elected a member of the Board of Directors. Mr. Manion came to the Follansbee company in 1919 as a designer while the Toronto, Ohio plant was being built.

From 1920 to 1921 he was maintenance engineer and subsequently efficiency engineer for both plants of the company, later becoming chief engineer, which position he held until July, 1940, when he was elected vice president in charge of operations at both the company's Toronto, Ohio, and Follansbee, West Virginia plants.

He is an active member of the Association of Iron and Steel Engineers.

John F. Byrne was elected as a vice-president of Koppers United Company. Mr. Byrne is general manager of Koppers United Company's blast furnace division, Granite City, Illinois, and will continue in that position.

Mr. Byrne was made general manager of the newly-created blast furnace division in 1941 when Koppers United took over reconditioning and operation of the two long-idle blast furnaces of the former Granite City Pig Iron Company. One furnace was relighted in the fall of 1941 and the other in January of this year.

Mr. Byrne has been with Koppers since 1925, when he joined the company as a research chemist. He was transferred to the financial department in 1930 and served several years as an assistant to the vice president in charge of finance.

He attended the University of Pittsburgh and later the University of Utah, where he received a degree in metallurgical engineering. He received a masters degree in mining engineering at Carnegie Institute of Technology and also studied at the Harvard University Business School. He was a research chemist at the

(*Please turn to page 114*)

Double reduction worm gears for driving rotating platforms; four of 119.583 ratio and four of 133.25 ratio from 1750 r. p. m. motors.

for smooth, quiet drives

specify DE LAVAL WORM GEARS

The continuous wedging action of the De Laval worm gear transmits power without vibration, shock or noise. • Three or more teeth are always in contact, resulting in an even flow of torque and great strength. • Both motor and driven machine are saved the impact of gear or sprocket teeth. Frequently the product is improved or the machine can be speeded up because of the absolutely uniform motion. Operatives do more and better work when not annoyed by noise and vibration. Describe requirements and ask for Publication W-1129.

Double reduction worm gear with vertical output shaft.

DE LAVAL

WORM GEAR DIVISION

of the De Laval Steam Turbine Co., Trenton, N. J.

MANUFACTURERS OF TURBINES STEAM, HYDRAULIC, PUMPS CENTRIFUGAL, PROPELLER, ROTARY DISPLACEMENT, MOTOR-MOUNTED, MIXED-FLOW, CLOGLESS, SELF-PRIMING CENTRIFUGAL BLOWERS and COMPRESSORS, GEARS WORM, HELICAL and FLEXIBLE COUPLINGS

H. E. BODECKER

T. W. PLANTE

THOMAS BROWN, SR.

United States Bureau of Mines, Pittsburgh, for three years before joining Koppers.

W. A. Edwards has been appointed Southwest District Manager of the Trumbull Electric Manufacturing Company. His headquarters will be held at Kansas City.

Mr. Edwards was transferred from the Boston territory, where he had been a field representative for the past two years. Previous to that for 15 years Mr. Edwards has been connected with the sales department at the Plainville factory of the Trumbull Company.

W. M. Shallcross, formerly of the Shallcross Control Company and more recently, of the Perfex Corporation, Milwaukee, Wisconsin, has joined the engineering staff of the industrial controller division of the Square D Company, of that city.

H. E. Bodecker, formerly superintendent of electrical and mechanical departments of Atlas Steels Limited, Welland, Canada, was recently appointed assistant general superintendent, Pittsburgh Metallurgical Company, Charleston, South Carolina. Mr. Bodecker first entered the steel industry in the tube mill electrical department at the La Belle Iron Works, now a part of the Wheeling Steel Corporation. After brief periods at the Farrell works of Carnegie Steel Company and the Middletown plant of American Rolling Mill Company, Mr. Bodecker became connected with Tennessee Coal, Iron and Railroad Company. Following two years in the electrical department of Wisconsin Steel Company and two years in electrical construction with Jones and Laughlin Steel Corporation, Mr. Bodecker joined the organization of the Crucible Steel Company of America at Pittsburgh, were he served 15 years before going to Atlas.

Robert W. Wolcott, President of the Lukens Steel Company, Coatesville, Pennsylvania, has been appointed special assistant to H. G. Batcheller, Director, Steel Division, War Production Board, to handle problems of procurement, allocation, and use of iron and steel scrap.

Mr. Wolcott, a recognized authority on steel scrap, has taken a leading part in the nation-wide effort to salvage critical materials for the war effort as the chairman of the American Industry Salvage Committee.

He was educated at Lehigh University, Bethlehem, Pennsylvania. Prior to the entry of the United States in the previous World War, he was a member of the Council of National Defense, Engineering Division. In September, 1917, he enlisted in the U. S. Naval Aviation Service, and continued on active duty until January, 1919, when he was placed on inactive status with the rank of lieutenant commander.

Mr. Wolcott has been president of the Lukens Company since 1925.

Edward C. Myers, assistant director of public relations, Pittsburgh District, has joined the staff of the director of industrial relations, United States Steel Corporation of Delaware, as senior staff assistant in charge of personnel.

Mr. Myers entered the safety department of the Homestead Works, Carnegie-Illinois Steel Corporation, in June, 1934. On January 1, 1937, he became director of personnel, training and welfare, of the works. In November, 1938, he was transferred to the United States Steel Corporation of Delaware in a public relations capacity, and on February 16, 1942, was promoted to the public relations position which he has held until his present appointment.

T. W. Plante, who has been assistant superintendent of the Eliza Furnaces at Pittsburgh Works, Jones and Laughlin Steel Corporation, since 1938 has been appointed superintendent of blast furnaces, coke works and ore docks at Otis Works. He has been with Jones and Laughlin Steel Corporation since his graduation from Carnegie Institute of Technology in 1923.

Thomas Brown, Sr., who has been assistant superintendent of blast furnaces at Otis Works, Jones and Laughlin Steel Corporation, since 1938 has been appointed superintendent of blast furnaces at Otis Works. He has been at Otis since 1922 and has been operating blast furnaces since 1895.

L. C. Steele who has been assistant master mechanic at Eliza Furnaces, Jones and Laughlin Steel Corporation, will succeed Mr. Plante as assistant superintendent

and D. W. Smith, of the combustion department, will succeed Mr. Steel as assistant master mechanic.

Charles F. Christopher recently resigned as special engineer, Steel Company of Canada, Hamilton, Ontario, to take care of all steel melting operations of Continental Roll and Steel Foundry Company. His time will be divided between the company's plants at Coraopolis, Pennsylvania, Wheeling, West Virginia, and East Chicago, Indiana.

Obituaries

Peter C. Patterson, 73, former vice president, National Tube Company, Pittsburgh, in charge of engineering and operations, died March 4. He joined the company in 1886 as a draftsman, later becoming foreman and superintendent of the Lapweld mill, chief engineer, assistant vice president in charge of operations and vice president in 1926, serving in that acpacity until his retirement in 1936.

George F. Downs, 70, former president, Lackawanna Steel Company, Lackawanna, New York, died March 1, in Palm Beach, Florida. He joined Lackawanna Steel in 1905 as assistant plant superintendent. In July, 1920, he was elected president, from which position he resigned in 1922 after the merger of Lackawanna with Bethlehem Steel Corporation.

Scott Follansbee, 53, Cleveland district sales manager, Follansbee Steel Corporation, Pittsburgh, died March 7, in Cleveland. Before going to Cleveland Mr. Follansbee made his home in Pittsburgh, where his father founded the Follansbee organization many years ago.

Charles Arthur Davis, aged 55, assistant general superintendent of the Youngstown Sheet and Tube Company's Youngstown district plants for fourteen years, died recently. Coming to Youngstown from Chicago thirty-five years ago, Mr. Davis joined the Sheet and Tube as a roller on one of the old hand sheet mills in the Campbell plant. The old mills were dismantled a few years ago after the new wide strip mill was built. Establishing an early reputation as a leader, he was appointed assistant superintendent of the sheet mill in 1920 and advanced to superintendent several months later. He was named assistant general superintendent of the Youngstown district plants March 19, 1929, a position which he held when he died. Born in Cynthiana, Kentucky, he first entered steel work in Chicago. He secured his first job at the Sheet and Tube Company, July 11, 1907.

C. A. DAVIS

Stanton Hertz, vice-president and assistant to the president of the Copperweld Steel Company, Glassport, Pennsylvania, lost his life in a fire in his home in Pittsburgh, Pennsylvania, on Saturday, February 27. A 13-year old daughter, Alice, also perished, while his wife, Mrs. Hertz and another daughter, Lois, were critically injured.

Mr. Hertz was born in Montgomery, Alabama, on June 17, 1894, and was a graduate of Alabama Polytechnic Institute at Auburn, Alabama. He served as lieutenant in the Engineers Corps in World War I. In 1921 he started his career with Copperweld and served successively as chief engineer at the New York Office, general manager of sales, and vice-president. Mr. Hertz served as executive director of the Copper Wire Engineering Association for five years beginning in 1936 and on his return to Copperweld in 1941 assumed the position he held at his death.

John W. Hughes, superintendent of the 98 in. hot strip mill, Republic Steel Corporation, Cleveland, Ohio, died February 20th. Mr. Hughes was born in Sharon, Pennsylvania in 1889 and attended public schools at Niles, Ohio, and the Warren, Ohio business college. He entered the banking business in Niles and, after about four years, started in what is now the Warren Plant of Republic Steel in 1913, working in various positions until 1929, when he was made superintendent of the hot strip finishing. He held this position for four years and for four years more was superintendent of all hot strip departments in Warren. He came to Cleveland at the time of the construction of the 98-inch strip mill and remained as superintendent of the mill after its construction.

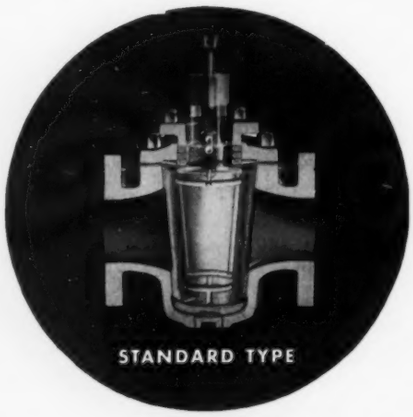
JOHN W. HUGHES

Mr. Hughes was president of the Trumbull County Foremen's Club for two years and a member of the Warren Board of Education for six years and president for four years. He was married to Emma Marie Totterdale and has one daughter.

NORDSTROM

Lubricated Plug

VALVES



STANDARD TYPE

NORDCO STEEL TYPE

EMCO-NORDSTROM TYPE

The safest valves for war time service in steel plants, for oil, gas and chemical lines.

Keep upkeep down

MERCO NORDSTROM VALVE CO.

A Subsidary of Pittsburgh Equitable Meter Co.

Main Office: Pittsburgh, Penna. Branches: Boston, Buffalo, Brooklyn, Chicago, Columbia, S. C.; Des Moines, Houston, Kansas City, Los Angeles, Memphis, New York City, Oakland, Philadelphia, San Francisco, Seattle, Tulsa.

Embodying an industrial "Four Freedoms"

MORGANITE BRUSHES

Top brush performance—efficient operation in motorized applications—is obtainable with MORGANITE brushes. Taking the gigantic Victory power loads in their stride, these brushes emphasize freedom from excessive energy loss, freedom from sparking, from noise, and from undue maintenance.

For years a leader in peace-time production, MORGANITE brushes are now widely specified for military and naval equipment. The advantages embodied in these products are available for your essential work, too.

WRITE FOR DATA BOOKLET

The MORGANITE 30-page informative booklet is available on request without obligation. The correct type, body, material and application are described in detail.

MORGANITE BRUSH CO.

INCORPORATED

LONG ISLAND CITY, NEW YORK

BUILT BY MORGAN *Engineering*

DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE MILLS STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIPPING MACHINES • SOAKING PIT CRANES • ELECTRIC WELDED FABRICATION • LADLE CRANES • STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

60″ COLD SAW AND GAG STRAIGHTENER

● Among the types of special machinery built by Morgan Engineering skill, is this 60″ Cold Saw, designed for sawing up to 24″ structural sections. It is of heavy duty construction throughout, with arbor mounted in Timken bearings. A range of saw feeds is obtained by a variable speed motor.

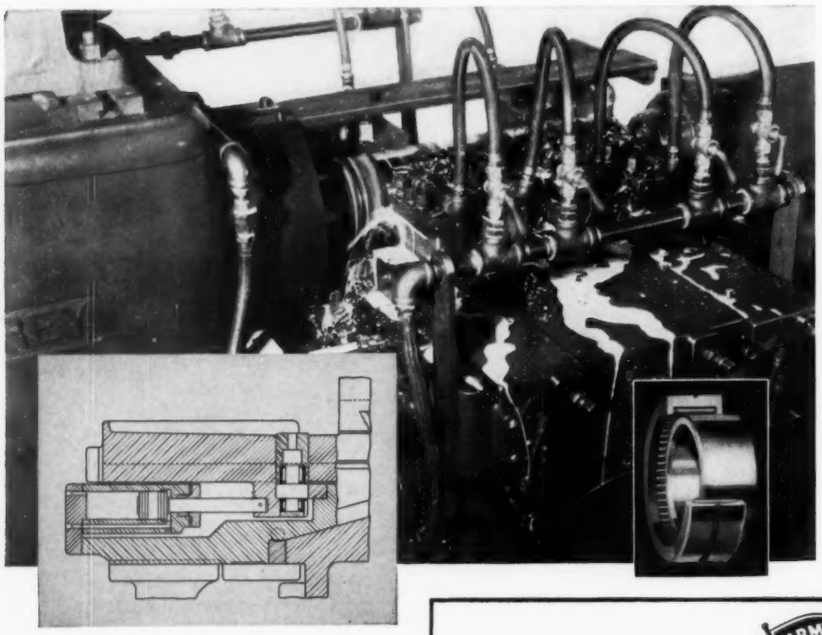
At the rear of the saw is shown a Morgan Gag Straightener for straightening up to 24″ I beams.

Throw Your Scrap Into the Fight

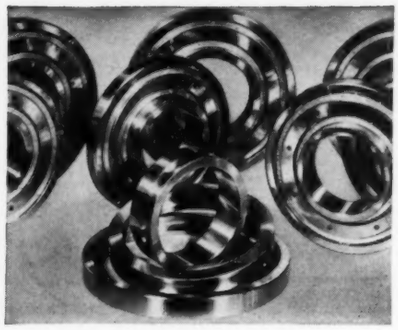
THE MORGAN ENGINEERING CO., ALLIANCE, OHIO

Pittsburgh, 1420 Oliver Building

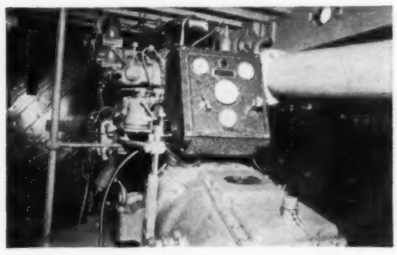
TO SPEED THE ANNEALING of iron alloys, these furnaces built by Continental Industrial Engineers, Inc., are designed for rapid handling of the work. Metal to be heat treated glides smoothly into the furnace on easy-turning rollers. As shown in cross-section, each roller turns on an anti-friction bearing unit assembled from Bantam Needle Rollers. A hardened sleeve, also furnished by Bantam, forms the outer raceway.



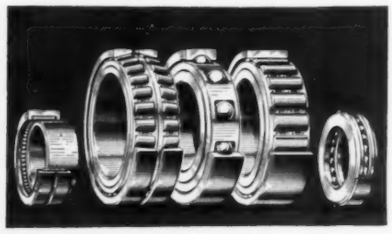
IN MACHINE TOOLS, the Quill Bearing's small size, high capacity, low friction coefficient, and efficient lubrication make it possible to combine long life, low power consumption, and compact product design. A typical instance is the use of Quill Bearings on the front carriage assembly of Semi-Automatic Shell Lathes built by Morey Machinery Co., Inc. For further details on this unusual anti-friction bearing unit, write for Bulletin E-104.



DESIGN OF SPECIAL BEARINGS is an important aspect of Bantam's service in meeting unusual requirements. These triple-race radial ball bearings were designed to eliminate starting friction in dynamometers, where this variable factor would seriously affect the accuracy of the test results. Very close dimensional tolerances were maintained in these bearings as an added assurance of accurate results.



IN MARINE APPLICATIONS TOO, Bantam Bearings play their part in improving product performance. Twin Disc Clutch Company uses Bantam Bearings for the throwout bearing on its widely used Marine Reverse and Reduction Gears, one of which is shown here on a 215-HP engine.



WHEN LARGE-SIZE BEARINGS ARE NEEDED, Bantam's experience in the design and manufacture of heavy-duty bearings is of special value. Bantam's line includes every major type of anti-friction bearing—in sizes up to the largest ever built. If you have a problem involving exceptionally severe bearing requirements, TURN TO BANTAM.

ARMY E NAVY

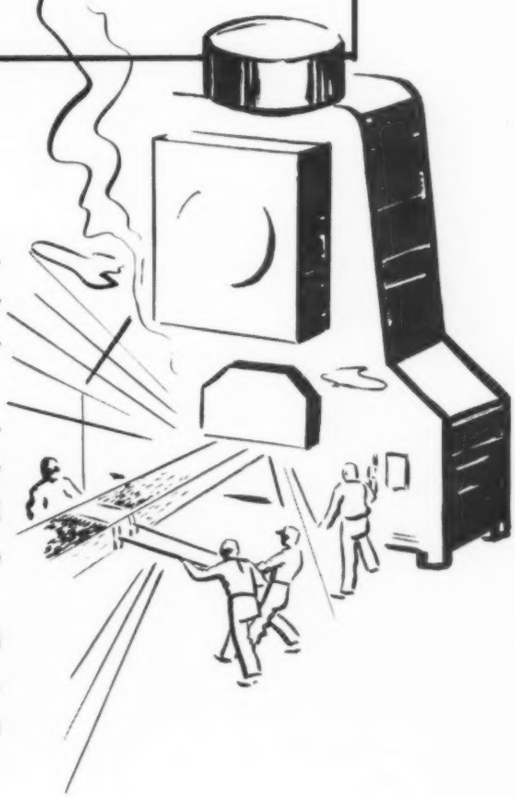
BANTAM BEARINGS

STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL

BANTAM BEARINGS CORPORATION · SOUTH BEND · INDIANA

SUBSIDIARY OF THE TORRINGTON COMPANY · TORRINGTON, CONN.

"COLD STEEL" *has no place here!*



A forging press or a rolling mill is no place for "cold" steel. The delivering of billets uniformly heated to the right temperature calls for skillful furnace engineering and well-designed burners.

Let Bloom Engineering show you how the proper application of modern burners can produce ideal results. In many cases, greatly improved heating conditions are obtained through relatively simple alterations, and with little or no disturbance to present operations.

Furthermore, with BLOOM LONG-FLAME BURNERS you can convert INSTANTLY from gas to oil or oil to gas.

To conserve fuel, improve your heating results, reduce costs, call Bloom!

BLOOM ENGINEERING COMPANY

857 WEST NORTH AVENUE · PITTSBURGH, PA.

Use This Check List

WHEN INSTALLING BRUSHES ON YOUR ELECTRICAL EQUIPMENT

1. See that all terminals are securely fastened to the brush holder support.
2. Remove dirt and grit from brush holders.
3. Provide $\frac{1}{8}$" to $\frac{3}{16}$" clearance between commutator and nearest portion of brush support in reaction and box type brush holders. Less clearance is sometimes preferable on small motors.
4. Keep angular position of all brush holders uniform with respect to the commutator.
5. Check neutral point and space the brush arms equidistant about the commutator.
6. See that toes of all brushes on each arm are parallel with commutator segment.
7. To prevent streaking of commutator, stagger brushes in positive and negative pairs.
8. Seat new brushes on commutators and rings accurately with sandpaper or a brush seating stone.
9. Adjust brush spring pressure to conform with manufacturer's recommendation.

Care exercised in the installation, fitting and adjustment of brushes increases life, improves performance and eliminates many of the possible causes of interrupted service.

NATIONAL TRADE-MARK *Carbon, Graphite and Metal-Graphite* BRUSHES

"National" brushes are doing their full share of carrying the enormous load demanded by the Nation's war effort. Essential requirements must be met first. Every effort is being made to satisfy all demands for our brushes in the shortest possible time.

Proper maintenance is paramount in keeping your electrical equipment operating at full efficiency. Many valuable and time saving suggestions as well as details of operations mentioned in the above check list are included in this series of "Modern Pyramids" bulletins. Copies are available promptly upon request.

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation

UCC

CARBON SALES DIVISION, CLEVELAND, OHIO

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THE WORD "NATIONAL" AND THE SYMBOL △△△ ARE REGISTERED TRADE-MARKS OF NATIONAL CARBON COMPANY, INC.

made to meet your needs

• Every Birdsboro "Special" Roll is individually engineered to meet the exact needs of the user. No hit or miss methods.

Your roll requirements are carefully analyzed and your Birdsboro Roll is made *specially* for you — to assure you longer roll life, greater tonnage and more rolling accuracy. If yours is a roll problem, it will pay you to consult Birdsboro.

For blooming mills, billet mills, structural mills, bar mills, rolling mild, structural, shell, gun barrel, seamless tube and special alloy steels. Also for 4-high strip mill back-up rolls and 3-high sheet rolls.

BIRDSBORO STEEL FOUNDRY & MACHINE CO. • BIRDSBORO, PA.

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ROLLS

The SAFE Modern Lubricant For Ball and Roller Bearings

1. Used and recommended by practically ALL makers of anti-friction bearings.

2. Makers of machinery and tools fitted with ball and roller bearings use NON-FLUID OIL to avoid bearing failures and insure most efficient service.

3. Steel mills guard against faults of using grease and obtain longest life from ball and roller bearings by using NON-FLUID OIL.

Used successfully in leading iron and steel mills. Send for instructive bulletins.

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NON-FLUID OIL
IN U.S. PAT. OFFICE & FOREIGN COUNTRIES

MODERN STEEL MILL LUBRICANT

Better Lubrication at Less Cost per Month

OHIO
Maximum Lift MAGNETS

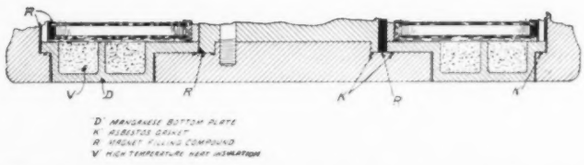
The Ohio 6 pancake coil magnet in the 55 and 65″ sizes will lift 35% more material on the average than the standard magnet.

The 8 pancake coil 55″ and 65″ magnets will lift 75% more than the standard magnets.

Labor cost per ton and time required to handle are both reduced correspondingly.

One large steel company bought a 6 coil 55″ magnet. It has since bought 19 more.

★When Ohio magnets are required to handle hot materials we can supply them with hollow bottom plate. Hollow spaces are filled with heat resisting material. See cut below.



D MANGANESE BOTTOM PLATE
K ASBESTOS GASKET
R MAGNET FILLING COMPOUND
V HIGH TEMPERATURE HEAT INSULATION

Such magnets can handle hot material all day.

Have you a fast lifting or hot lifting problem?

The OHIO Electric Mfg. Co.

5907 Maurice Avenue — Cleveland, Ohio

A. I. S. E. Spring Conference

UNDER THE AUSPICES OF THE

ROLLING MILL COMMITTEE

MONDAY, MAY 10, 1943 — **William Penn Hotel**

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Tentative Program

"A NEW DESIGN IN SOAKING PITS"
"BLOOMING MILL POWER AND MOTOR APPLICATION"
"THE MECHANICAL PARTS OF THE BLOOMING MILL"
"SCHEDULING THE BLOOMING MILL"
"TREATMENT OF THE BLOOMING MILL PRODUCT"

This is the first meeting of the newly formed ROLLING MILL COMMITTEE, organized in response to many requests from rolling mill men. Make it a success — plan to attend.

★ ★ ★

A. I. S. E. District Section Activities

PHILADELPHIA, APRIL 3rd

"Reconditioning of Flood Submerged Electrical Apparatus," by L. V. Black, Superintendent Electrical Department, Bethlehem Steel Company, Bethlehem, Pennsylvania.

"Field Balancing of Rotating Equipment," by B. A. Rose, Section Engineer, Mechanical Section, A. C. Generating Engineering, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

"The Selection and Care of Wire Rope for Principal Uses in Steel Plants," by J. U. Hoffman, Chief Contact Representative, Wire Rope Division, Bethlehem Steel Company, Williamsport, Pennsylvania.

"Shipyard Problems," by J. W. Gore, Electrical Superintendent, Bethlehem-Fairfield Shipyard, Inc., Baltimore, Maryland.

CHICAGO, APRIL 6th

"Selenium Rectifiers as a Heavy Current Power Supply," by C. A. Kotterman, Chief Engineer, Rectifier Division, International Telephone and Radio Manufacturing Company, East Newark, New Jersey.

PITTSBURGH, APRIL 12th

"Voltage Drop in A-c Collector Systems for Cranes and Bridges," by W. K. Boice, General Electric Company, Schenectady, New York.
"Maintenance in War-Time," by T. R. Moxley, Wheeling Steel Corporation, Steubenville, Ohio.

DETROIT, APRIL 13th

"A Modern Soaking Pit," by P. M. Offill, Amsler-Morton Company, Pittsburgh, Pennsylvania.

13 years of continuous control operation
—THAT'S RELIABILITY!

BE PREPARED *for any emergency with dual-fuel control. Blast furnace gas or powdered coal is burned in the boilers operated by this Hagan Control System in a large steel mill. The same arrangement can be made for oil and powdered coal, or for other fuels.*

IN 1930 a prominent steel corporation built a new power plant to supply steam and electric power to one of its mills. The plant contained four boilers, all of which were equipped with Hagan Automatic Combustion Control.

Two of the boilers were fired with blast furnace gas and two were fired with a combination of blast furnace gas and powdered coal. Provision was made to use all the blast furnace gas available and, at the same time, protect the two boilers using blast furnace gas alone. Any deficiencies in blast furnace gas were to be compensated for by automatically starting and stopping the powdered coal-fired burners in the second two boilers. This operation at that time was both new and spectacular. In fact, Hagan is still the only control manufacturer to successfully engineer such a system.

So reliable was the original installation that when the plant was expanded in 1937 and a new 500,000 lb. per hr. boiler added, Hagan Control was again chosen. Today, 13 years after the initial installation, both the original boiler control and the later installation are working every minute of the day.

Reliability is the first requisite of combustion control for steel mills. Every piece of Hagan equipment is engineered with this in mind. That's why many of the first Hagan installations are still giving good service 20 to 25 years after installation. Write for literature on Hagan Control for any type of steel mill application.

HAGAN CORPORATION · HAGAN BUILDING · PITTSBURGH, PA.

HAGAN *Automatic* COMBUSTION CONTROL

The pioneer . . . and still the leader

IDLE EQUIPMENT HELPS THE AXIS!

FIND A USE FOR IT—OR SCRAP IT!

Follow this rule

If it hasn't been used for three months, and if someone can't prove that it's going to be used in the next three—sell it*—or scrap it!

Here's what to look for

Obsolete machinery, tools, equipment, dies, jigs, fixtures, etc., which are incapable of current or immediate future use in the war production effort because they are broken, worn out, irreparable, dismantled or in need of unavailable parts necessary to re-employment.

*** Scrap and Used Equipment Dealers pay well for usable machinery and materials.**

NOW is the time to look over all the machinery and materials that this war has forced into idleness. Every pound of it can be helping the war effort. And if it isn't, then it's helping der Fuehrer!

SCRAP IS AMMUNITION

Look at it this way. There is, in America, the worst shortage of equipment of every sort that has ever faced us. There is an even greater lack of heavy scrap. *You* can help relieve these shortages. You can add to the Nation's productive might. You can help provide the steel that will drive the Hun and Jap back into their holes to die.

You owe it to your Country, and to the boys that face these gangster nations, to do this thing that's asked of you. And don't pass off your responsibility by saying that you've already done the job . . . *because you haven't!*

FIRST SCRAP HUNT — JUST A STARTER

Even if you've recently carried out a scrap drive in your shop, surveys prove there is always plenty that is missed the first time. You can prove this for yourself, simply by taking a careful look around. Remember — if you are hanging on to material or equipment on the basis that you may need it after the war, you're not only holding out on our fighting men . . . you're fooling yourself as well. For it's going to take everything we've got to win this war—and if we *don't* win, the stuff you've hoarded won't do you a nickel's worth of good.

If you haven't started a Salvage Committee working yet—get going now. Pick a high executive as Salvage Manager; one who has the authority to get things done. Write to this magazine, if you wish, for help in getting a real salvage program rolling.

YOUR IDLE EQUIPMENT IS 1-A

Nobody's asking you to give valuable machinery and materials away unless you want to. There's a ready market for heavy industrial scrap—it's needed in tremendous quantities to mix with the mountains of flimsy household scrap collected last Fall. Used Equipment Dealers and Scrap Dealers will purchase usable pieces at good prices. These dealers can be located in the classified telephone book.

Decide right now to get going on this thing—and don't let anything delay you further. See to it that your own personal scrap record does not read . . . "TOO LITTLE AND TOO LATE!"

BUSINESS PRESS INDUSTRIAL SCRAP COMMITTEE

ROOM 3303, EMPIRE STATE BLDG., N. Y. C.

If you have done a successful salvage job at your plant, send details and pictures to this magazine.

SEND FOR THIS SCRAP MANUAL TO HELP YOU TACKLE THE SALVAGE PROBLEM

BUSINESS PRESS INDUSTRIAL SCRAP COMMITTEE
ROOM 3303, EMPIRE STATE BLDG., N. Y. C.

Please send scrap manual

Your name . . . . . .

Company name . . . . . .

Company address . . . . . .

NEW MEMBERS

Active

D. J. Branning
Assistant Superintendent Mechanical Dept.
Bethlehem Steel Corporation
Sparrows Point, Maryland

C. R. Dobson
Chief Industrial Engineer
Jones and Laughlin Steel Corporation
Pittsburgh, Pennsylvania

H. W. Dorset
Assistant to Electrical Engineer
Bethlehem Steel Corporation
Sparrows Point, Maryland

C. Arthur Fullman
Consulting Engineer
Kaiser Company, Inc., Iron and Steel Div.
Oakland, California

August Giese
Division Superintendent Plant Maintenance
Carnegie-Illinois Steel Corporation
Gary, Indiana

Glenn O. Hainer
Utilities Engineer
Columbia Steel Company
Pittsburg, California

William A. Holt
Assistant Superintendent Mechanical and Electrical Department
Atlas Steels, Ltd.
Welland, Ontario, Canada

E. M. Kropp
Assistant Chief Industrial Engineer
Republic Steel Corporation
Cleveland, Ohio

J. A. Lafferty
Superintendent Roll Shops
Republic Steel Corporation
Warren, Ohio

Edward J. McCann
General Works Manager
South Chester Tube Company
Chester, Pennsylvania

T. F. Rahilly, Jr.
Assistant Mechanical Superintendent
Algoma Steel Corporation, Ltd.,
Saulte Ste. Marie, Ontario, Canada

Joe Shipley
Temper Unit Sticker
Republic Steel Corporation
Niles, Ohio

Julius H. Strassburger
Manager Department Service and Maintenance
Weirton Steel Company
Weirton, West Virginia

Eric Taylor
Electrical Engineer
Atlas Steels, Ltd.,
Welland, Ontario, Canada.

Associate

Howard H. Blouch
Electroplating Development Manager
E. I. duPont deNemours and Company, Inc.
Cleveland, Ohio

William A. Briggs
Squad Leader — Electrical Draftsman
James Stewart and Company
Chicago, Illinois

William S. Hogg, Jr.
Motive Power Battery Sales
The Electrical Storage Battery Company
Pittsburgh, Pennsylvania

Arthur H. Hoving
Assistant Chief Equipment Engineer
James Stewart & Company
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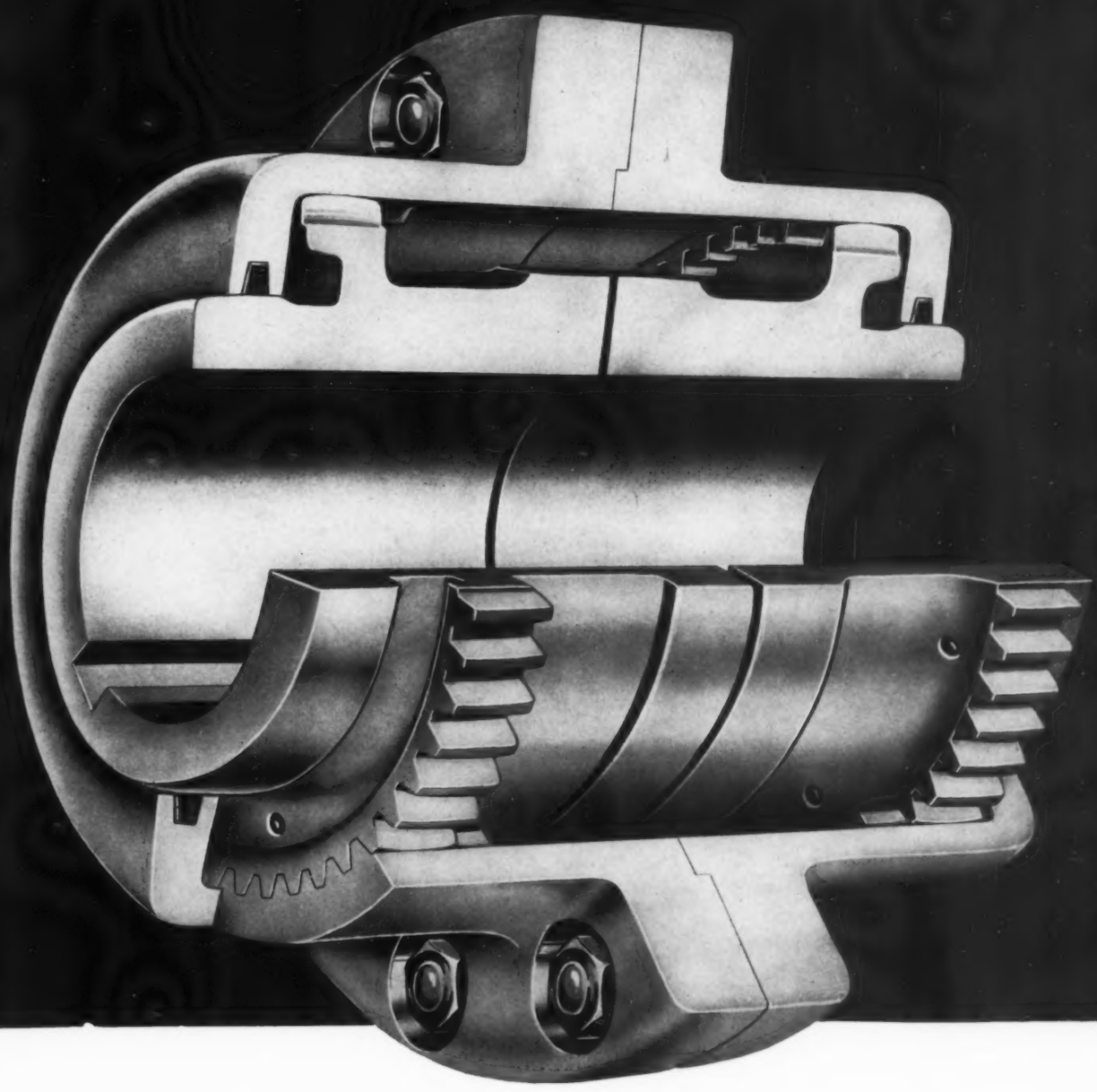


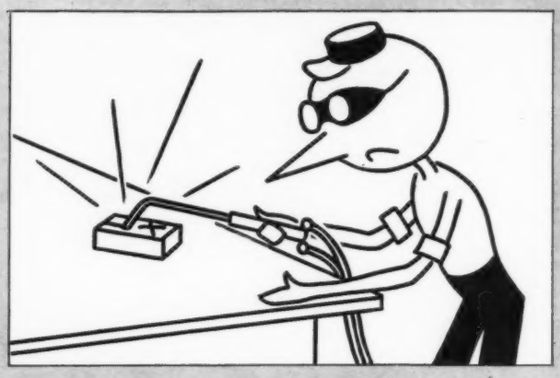
A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY WOODBERRY, BALTIMORE, MD.

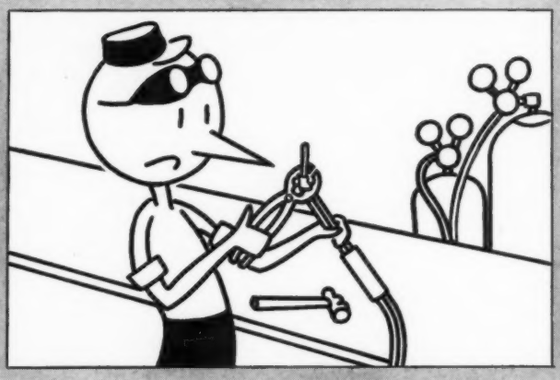
WELDER SPARE THAT TORCH!

1 Don't use your torch as a hammer. It isn't built to stand such abuse. Even the best cutting torch makes a very poor hammer.



2 Don't rub your torch tip on the work or rough surface to clean it. It's liable to damage the orifices and impair the efficiency of the torch.

3 Don't pry metal plates or sheets apart with your welding torch. A bar or chisel does a much better job, and eliminates danger of damage to the torch.



4 Don't use gas pliers on torch or regulator connections. Use your regular torch wrench and prevent damage to brass parts.

Take Good Care of Your Welding Equipment

Common-sense tells you that good care will mean longer service from your torches, tips, and regulators. That's important today because welding and cutting equipment is hard to replace.

Make it your duty to keep your welding apparatus in the best working condition by avoiding needless abuse and mishandling. In that way you'll be helping to fight waste and speed war production.

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IDLE CYLINDERS ARE PRODUCTION SLACKERS: *Keep 'em rolling for victory!*

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THE ARMY THAT'S FIGHTING Time

In countless mills, shipyards, factories and shops—from coast to coast—a vast army of American workers drives on, determined that our fighting forces shall be equipped and supplied IN TIME. The armament these workers employ consists of machines and machine tools—with which they are fighting against time to produce the ships, planes, tanks, guns, munitions and transport needed on the fighting fronts.

In order that production shall not lag, MACHINE BEARINGS MUST NOT FAIL. They must be adequate—in design, materials and construction. They must be well cared for—kept clean—well lubricated with the right oil or grease—periodically inspected, to detect the first sign of distress. Replacements for emergencies should be at hand.

On the production lines of America—in thousands of machines, machine tools and other vital shop equipment, ranging from tiny instruments of precision to massive mill units — NORMA-HOFFMANN PRECISION BALL AND ROLLER BEARINGS are contributing frictionless operation, accuracy, rigidity and dependability to the machine performance that is winning Victory over time.

Let our engineers help you, with their 30-odd years of experience in the application, operation and maintenance of bearings.

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PRECISION BEARINGS
BALL, ROLLER AND THRUST

NORMA-HOFFMANN BEARINGS CORP'N, STAMFORD, CONN. FOUNDED 1911

Saving Maintenance

WITH KLAMP-TITE SWITCHES

FIG. 1

FIG. 2

FIG. 3

A 10,000 ampere, low-voltage Klamp-Tite in closed position, Fig. 1; in closing position, Fig. 2; and in fully-opened position, Fig. 3.

FIG. 4

FIG. 5

Klamp-Tite Switches are of many types, for service from 1600 amperes up. Figs. 4 and 5 are of 5000 and 4000 ampere capacity, respectively.

WHEN a Klamp-Tite Switch is closed, contacts bear against terminals under thousands of pounds constant pressure. The surfaces, silvered and pressed together, can remain in closed position for years without maintenance.

In Klamp-Tite design, heavy bronze bars which produce positive contact pressure are located outside the current path where they are not subject to overheating and distortion.

The elements in conventional switches which make for frequent inspection and maintenance are entirely absent in Klamp-Tites. Consequently, Klamp-Tites can be depended upon to protect critical production schedules.

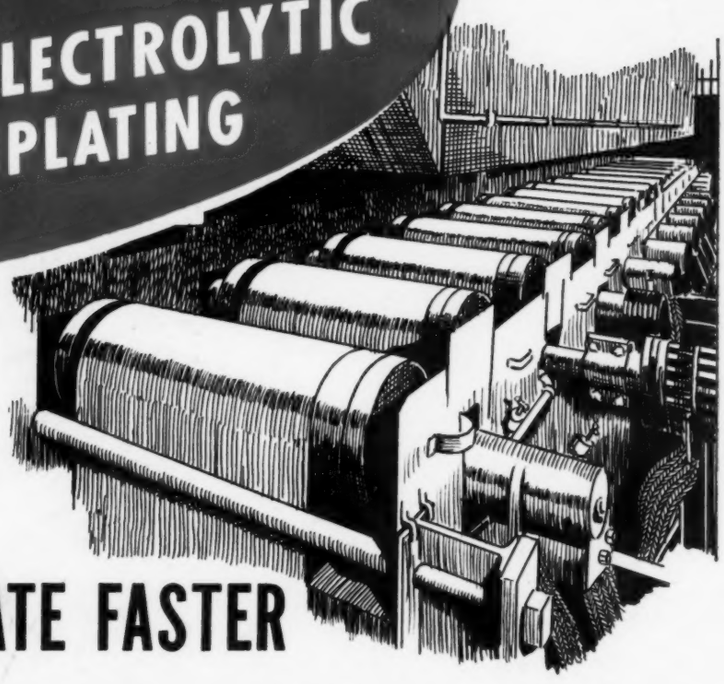
AIR SWITCHGEAR

IMMERSED IN AIR • ENCASED IN STEEL

Representatives in Principal Cities

I-T-E CIRCUIT BREAKER CO., PHILADELPHIA, PA.

60,000 AMPERES FOR CONTINUOUS ELECTROLYTIC TINPLATING



YOU CAN TINPLATE FASTER AND SAVE ⅔ THE PRECIOUS TIN

A copper-oxide rectifier unit for electrolytic tinning—5000 amp, 9 volts d-c. Approximately 9 ft high, 7 ft wide, and 6 ft deep.

THE electrolytic method of plating, for which General Electric has installed the electric equipment in several mills, produces tinplate at the rate of 500 feet per minute, and uses only ⅓ as much tin as the hot-dip method. This high-speed, low-cost method, which is economically justifiable under normal circumstances is becoming a ***must*** under war conditions.

The G-E dry-type rectifiers used on electroplating lines are easy to install, and they provide long life because there is nothing to wear out. No special foundations, or auxiliary venting or cooling equipment is required and, where floor space is at a premium, the rectifiers can be placed on balconies or platforms above the floor. Their control is extremely accurate, since saturable-reactor load control gives operation comparable to generator-field control.

If you would like more information about electric equipment for the new electroplating lines, see our representative at the G-E office nearest you. ***General Electric, Schenectady, N. Y.***

GENERAL ELECTRIC

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